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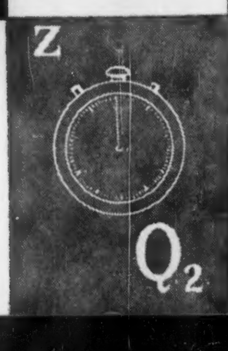

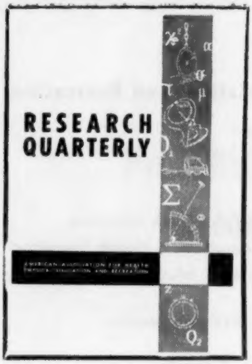

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Prevalence of Certain Harmful Health Misconceptions among Prospective Elementary School Teachers

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Abstract

A special instrument in the form of a health opinionnaire was constructed, evaluated, and administered for the purpose of determining the prevalence of certain harmful health misconceptions among freshman prospective elementary school teachers attending state teachers colleges in New England and the extent to which that population was aware of the harmfulness of these misconceptions. Analysis indicated that the participating trainees subscribed to many harmful health misconceptions and that those who were aware of the misconceptions were also aware of their harmfulness. Analysis of variance indicated that those who had health and biology or biology subscribed to fewer misconceptions to a highly significant degree.

IT IS THE responsibility of the school to help children acquire the correct concepts concerning healthful living during their formative years. In order that the school may achieve this objective it is essential that elementary school teachers be aware of health misconceptions and their harmfulness. A teacher who subscribes to health misconceptions, or who is not aware of their harmfulness, may easily pass on erroneous information to many children.

There is some justification for the assertion that adults possess many erroneous concepts concerning health. Evidence of this is indicated by the flourishing sale of certain worthless patent medicines and the success of numerous charlatans who are making a profitable business from gullible customers. Previous studies by Salt (6), Dzenowagis (3), Rhoton (5), and Borozne (1) also reveal the widespread prevalence of health misconceptions among various groups of individuals.

The major purposes of this study were (a) to construct and evaluate an instrument for determining the prevalence of certain harmful health misconceptions among prospective elementary school teachers, (b) to determine the prevalence of the misconceptions among freshman prospective elementary school teachers attending state teachers colleges in New England, and (c) to determine the extent to which those prospective elementary school teachers were aware of the harmfulness of the misconceptions.

Procedures

Two hundred and one statements which were indicated to be health misconceptions were compiled from previous studies; published books and articles; contributions from various students, teachers, and physicians; and such forms

of advertising media as newspapers, radio, television, and magazines. Through the use of a special instrument, these statements were validated and evaluated by a jury of experts consisting of two health education specialists and 27 doctors of medicine having varied fields of specialization. The doctors of medicine included six general practitioners, four pediatricians, four psychiatrists, four surgeons, two pathologists, an assistant professor of neurobiology, a clinical assistant in medicine, a dean of a medical school, a dermatologist, an eye and ear specialist, a gynecologist, and an instructor of medicine. Each statement that was in their opinion a health misconception was assigned a rating of 0—not harmful, 1—slightly harmful, 2—moderately harmful, or 3—extremely harmful.

An instrument similar in nature to the jury instrument, in the form of a health opinionnaire, was developed. It contained 55 true health concepts selected from the studies completed by Merrill (4), Staton (7), and Boyd (2), and 130 items rated by all jurors to be harmful health misconceptions distributed through the topical areas of nutrition, exercise, first aid, personal hygiene, drugs and patent medicines, care and prevention of disease, and mental hygiene. Instructions for the examinees were to indicate those statements they agreed with and disagreed with and to assign a harmfulness rating to the latter.

In May 1957 the instruments were administered to 1044 freshman prospective elementary school teachers attending 17 of the 20 state teachers colleges in New England having this specialized population. This sample comprised the total specialized population in four states and two-thirds of the population in the remaining two.

Findings

Analysis of the data indicated that the participating trainees subscribed to many harmful health misconceptions regardless of the college they attended. Ten percent or more subscribed to 72 of the 130 misconceptions. The mean prevalence was 20.3.

Mean prevalence according to college ranged from 15.3 to 26.0. Analysis of variance indicated highly significant differences. Those having college subject matter experience in health, biology, and the combination of health and biology subscribed to fewer (in that order) than did those having neither health nor biology. The mean prevalence was 20.5, 19.6, 19.5, and 23.4 respectively. Analysis of variance indicated that those who had health and biology or biology subscribed to fewer misconceptions to a highly significant degree.

As determined by the use of chi square there was no significant difference in the type of misconceptions prevalent according to subject matter experience as stated above.

Comparison of mean harmfulness ratings assigned by the jurors and trainees indicated that the trainees who were aware of misconceptions were also aware of their harmfulness.

The instrument, which is easy and quick to administer, is valid and has adequate discriminative power in that 99 of the misconceptions exceeded the nominal 5 percent value of chi square. It has satisfactory reliability (.89) as determined through Hoyt's method using analysis of variance.

The misconceptions to which 10 percent or more of the prospective elementary school teachers subscribed and the mean harmfulness ratings assigned to each by the jury of experts are listed in the appendix.

Recommendations

There is justification for the assertion that greater emphasis should be given to health instruction at all educational levels and that existing courses and curriculums for elementary school teachers be revised to incorporate units of study specifically designed to treat the subject of health misconceptions.

Appendix

PREVALENCE OF CERTAIN HARMFUL HEALTH MISCONCEPTIONS AMONG PROSPECTIVE ELEMENTARY SCHOOL TEACHERS

Health Misconceptions	Percent	Degree of Harmfulness [a]
1. A mouthwash is healthful because it helps kill germs in the mouth and throat	68	1.0
2. A blind person has a keener sense of touch and hearing because the strength normally in the eyes has gone to other sense organs to make them more acute	64	1.0
3. The main purpose of a dentifrice is to kill bacteria	58	1.7
4. Arch supports should be used by all people with flat feet	56	1.4
5. A daily bowel movement is always necessary for good health	54	2.1
6. Alcohol is a stimulant	51	1.9
7. Six-year molars are replaced with second teeth	50	1.9
8. Cutting or shaving a person's hair makes it grow faster and thicker	45	1.0
9. Wearing bathing hats or ear plugs while swimming will ensure protection for the ears	44	1.7
10. The use of lanoline restores the natural oils lost as a result of washing the hair	44	1.4
11. When training children one should recognize the fact that they are miniature adults and treat them accordingly	39	2.6
12. Chewing on bones or hard objects strengthens the teeth	37	2.1
13. It is a bad health habit to drink water while you exercise	36	1.2
14. The main function of perspiring is to eliminate body poisons	32	1.2
15. Application of butter is an effective treatment for burns	31	2.0
16. It is necessary for optimum health to keep the windows open in the bedroom at night	31	1.5
17. People with too much acid in their systems should avoid all citrus fruits	31	2.2
18. Once you stop exercising, muscle changes to fat	30	1.9

[a] A degree of harmfulness was assigned to each misconception by a jury of experts and is indicated by the following numerical ratings: 3—extremely harmful; 2—moderately harmful; 1—slightly harmful.

19. The best way to lose weight is by exercising	28	2.2
20. The best thing to do when your muscles are stiff is to work the stiffness out by taking further vigorous exercise	26	2.2
21. Regular vigorous exercise increases a person's resistance to infectious diseases	26	1.8
22. The cause of overweight in most cases is lack of exercise	26	2.5
23. There are no living germs in pasteurized milk	25	1.3
24. Persons can clean their blood by eating certain foods	25	2.1
25. There are certain medicines that will prevent and cure the common cold	24	2.3
26. A good way to treat frostbite is to rub the frostbitten part with snow	24	2.3
27. Hot food is more nutritious than cold food	24	1.2
28. The immediate treatment to be given for sprain or strain should be the immersion of the affected part in hot water	23	2.3
29. A cancer can be arrested, but it can never be completely cured	23	2.8
30. Overexercise is a cause of heart disease	22	2.0
31. Brushing the teeth after every meal is a sure way of stopping tooth decay	22	1.4
32. "Feed a cold and starve a fever" is a good health rule to follow	22	2.2
33. Plenty of exercise in the fresh air is the best treatment for tuberculosis	22	2.9
34. Freezing will kill all bacteria	21	2.7
35. The less you eat during hot weather the less you will feel the heat	21	1.3
36. A good way to help a person get rid of the hiccoughs is to frighten him	21	1.7
37. Being massaged regularly is effective in weight reduction	20	1.7
38. Fish is a brain food	19	1.0
39. A craving for a certain food is an indication that the system needs that particular food	19	1.7
40. All men are created with equal capacity for achievement	18	2.4
41. Acid and alkaline foods should not be eaten together	18	1.5
42. Iodine is the best treatment for infection caused by stepping on rusty nails	18	3.0
43. People who are strong and healthy are sufficiently fortified against communicable diseases	18	2.5
44. It is a good idea for all persons to take vitamin pills daily	17	1.7
45. A pain in the lower back is generally a sign of kidney disease	17	2.2
46. A pain in the right side usually means that one has appendicitis	17	1.9
47. The best way to treat a black eye is to put a piece of raw meat on it	16	1.5
48. Celery is a nerve tonic	16	1.0
49. The healthiest people go to a doctor only when they feel sick	16	2.4
50. It is a good idea to hold whiskey or aspirin on an aching tooth	15	1.7
51. Sugar diabetes is caused by eating too many sweets	15	2.0
52. Tuberculosis is inherited	14	2.5
53. If you have a good tan you cannot get sunburned	14	2.3
54. Slow learners remember better than the fast learners	13	1.8
55. Overweight is usually due to faulty glands	13	2.4

56. Every disease needs a drug or medicine for its cure	13	2.5
57. Cancer is communicable	12	2.6
58. A person who has mental illness lacks will power	12	2.4
59. Persons who have pimples or boils usually have bad blood	12	2.0
60. Because of the federal food and drug act all cosmetics are healthful to use	12	2.1
61. Eating foods with plenty of vitamins will prevent tooth decay	12	1.4
62. A frequent cause of heart disease is athletics	12	2.0
63. People are born with their food likes and dislikes	12	1.6
64. A child's natural likes and dislikes will lead him to choose a balanced diet	12	2.0
65. People who do not eat meat are bound to be in poor health	11	1.5
66. It has been proved that most mental sickness is inherited	11	2.4
67. People should use aspirin to cure a cold	11	1.8
68. It is always safe to drink water which has just been taken from a deep well or spring	11	2.7
69. Brandy should be administered to revive a person who has fainted	11	2.8
70. Laxatives should be used at least once a month in order to clean out accumulated body wastes	10	2.4
71. The occasional use of sleeping pills without a doctor's advice is permissible	10	2.4
72. To go on a diet always means to eat less food	10	1.7

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(Submitted 8/3/59)

Relationship of Selected Measures of Acting Body Levers to Ball-Throwing Velocities[1]

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Abstract

The purpose of the study was to determine the relationship between selected measures of body levers contributing to throwing and the ball velocities achieved in the overhand and underhand throws. Motion picture data were obtained of the throwing performance of 42 high school girls, arranged in three groups on the basis of differences in initial throwing velocity achievement. Structure length and moment-arm measures of acting body levers for trunk rotation, medial rotation and flexion of the arm, and flexion of the wrist were studied. These subjects demonstrated a pattern of acting lever length contribution to overhand throwing velocity. Moment-arm measures of acting levers were found to have considerable predictive power relative to the overhand throwing velocity achieved. A similar relationship was not found between structure-length measures and overhand throwing velocity. Results with the underhand throws indicated that neither length of body segments nor the position of the acting lever at the moment of release of the ball was a critical factor in determining the velocity of the throw.

KINESIOLOGISTS ARE INTERESTED in the application of principles of leverage to human movement as a means of increasing understanding of the characteristics of skilled movement. Careful movement analysis and experimental study of the action of body segments serving as levers in the several throwing patterns may promote increased efficiency in the teaching and learning of throwing skills in sports and physical education.

Hartson (7) speaks of movement analyses which are concerned with the process of the movement and others concerned with the product. The process of a movement such as the throwing movement is concerned with anatomical and physiological systems. In the study of movement the skeletal system has been described as a series of levers obeying general mechanical laws. The physiological system may be described in terms of the nervous and biochemical actions which allow muscles to act to move these levers. The product of the action of the skeletal and physiological systems may be termed human behavior—what the organism does to an object such as a thrown ball. Thus, the velocity achieved with a thrown ball is a product of the throwing-movement process.

Three approaches have been used in research studies of the throwing movement process. Haney (6) in a study of four above-average underhand pitchers was interested in determining and describing the movement pattern of skilled performers. Wild (11) and Jones (8) studied the differences in throwing

[1] This study was made in partial fulfillment of the requirements for the Doctor of Philosophy degree at the University of Wisconsin under the direction of Ruth B. Glassow and C. W. Harris.

movement patterns which could be noted between children of different ages and sex. Wild was able to describe in detail four overhand throwing patterns which were characteristic of different stages of development in the children studied. Brophy (3) in a study of the throwing pattern of nine college women started with subjects whose throwing performance was below-average and studied changes in the throwing process associated with an improvement in the product of the throw—increased throwing distance. The advisability of yet another approach to the study of the movement process, that of contrasting expert, average, and poor performance with respect to key elements in the performance has been suggested (1).

Purpose

The present study was designed to examine the process of the underhand and overhand throwing movement as related to a behavioral product, the velocity of the thrown ball, with three groups of subjects, each group representing a different level of throwing velocity achievement. It was the purpose of the study to determine whether there were differences in selected measures of the throwing process which could be shown to be related to differences in the ball-velocity product of the throw.

Procedures

The Sample. Subjects for the study included 42 high school girls chosen at random from the public high schools in Sioux City, Iowa, by a stratified random sampling procedure designed to permit the selection of subjects at three different levels of throwing velocity achievement. This stratified sampling procedure was adopted to ensure both a sufficient representation of skilled throws and a range of velocity performance. The sampling procedure made necessary the specification of throwing velocity limits for three groups of high school subjects. Limits for the average group ranged from $\frac{1}{4}\ \sigma$ below to $\frac{1}{4}\ \sigma$ above the mean; for the medium skilled group from $\frac{3}{4}\ \sigma$ to $1\frac{1}{4}\ \sigma$ above the mean; and for the highly skilled group from $1\frac{3}{4}$ to $2\frac{1}{4}\ \sigma$ above the mean.

Normative data were not available for throwing velocity achievements of girls, but a study by Brophy (3) provided a distribution of distance throwing scores for 173 freshmen college women. Calculation of velocity for each 5-foot distance in the Brophy data was made by using distance records and assuming a 45 degree angle of projection and a 5.5-foot height of release of the ball. By using the frequency data with each 5-foot interval it was possible to calculate an estimate of the mean and standard deviation for throwing velocity scores of the 173 college women. The calculated mean and standard deviation were compared with like statistics from a throwing velocity study conducted with 60 college women, using a specially devised indoor measurement technique. The mean and standard deviation values from the two sets of data were so similar that the values calculated from the Brophy data were used to establish throwfing velocity group limits as follows: Group 1 (average)—42-46 ft./sec.; Group 2 (medium skill)—50-54 ft./sec.; and Group 3 (highly skilled)—58-62 ft./sec.

These limits for the three levels of velocity scores desired in the study provided the means of stratifying the sample. The plan for the selection of subjects for the motion picture portion of the study involved random sampling and testing of the overhand throwing velocity skill of subjects from the defined high school population until 42 girls were found whose scores qualified them for inclusion in one of the three velocity groups. An indoor testing procedure[2] for determining velocity scores was worked out, checked, and found to have a consistency coefficient of .93. It was used in screening subjects for the three velocity groups.

Description of Variables. The acting levers for the overhand and underhand throws selected for study included the trunk, the arm, and the hand. These levers were believed to play a primary role in the achievement of throwing velocity with the two types of throws. The elbow extension action which occurs in the overhand throw was not studied since there is no comparable lever action in the underhand throw and it was planned to compare the lever actions for the overhand and underhand throws.

The description of the trunk rotation lever is similar for the overhand and underhand throws. The lever includes the trunk, upper arm, forearm, and hand. The axis of rotation is a line through the left hip joint. The action is medial rotation at the left hip. In the overhand throw the upper arm, forearm, and hand act as a second lever in medial rotation of the arm. The axis of rotation is a line extending the length of the humerus. This lever is called the arm lever in this study. For the underhand throw the arm lever includes the same segments, the whole arm and hand, but the action is flexion at the shoulder joint and the axis of rotation is a line through the shoulder joint. For both throws the hand acts as a third lever with the action as flexion of the hand at the wrist joint.

Lengths of the moment-arms for each of the acting levers were found by measuring the perpendicular distance from the line of action of the force in the throw to the axis of rotation (4, 10). The measure in each case was taken at the moment of release of the ball, the first frame in which the ball was definitely out of the hand. The line of action of the throwing force was defined as the direction in which the ball was going at release.

Body segment measures were defined as the length of an individual skeletal segment measured from a proximal joint to the adjacent distal joint. Because of the possibility of individual differences as to the manner of combining segments into acting levers, each bony segment which was considered to be contributing to leverage in the throw was measured separately. The nine segment length measures used for the study included hand length, shoulder breadth, pelvic breadth, foot length, trunk height, arm length, forearm length, leg length to floor, and thigh length.

Motion Picture and Measurement Techniques. Motion picture filming, tracing, and measurement techniques were used for obtaining (a) velocity scores

[2] Mimeographed directions for the indoor wall throw velocity test may be secured from the author on request.

achieved with overhand and underhand throws using softballs and baseballs, and (b) moment-arm measures of each defined lever acting in the throw. A third set of variables, the length of the body segments which made up the body levers, was obtained by direct anthropometrical measurement techniques.

Simultaneous front-and side-view motion pictures were taken of 12 overhand and underhand throwing trials of 42 high school girl subjects. Motion pictures were taken outdoors with two cameras using telephoto lenses from a distance of 80 feet. Camera speed was 64 frames per second. A timing device[3] powered by a 78rpm phonograph motor was placed at a 45 degree angle to the cameras and ran constantly during the filming of the throws. Time was determined by measuring the angles of movement of the clock hand and converting the angles to seconds.

Consistency of the clock action was checked by a comparison of the clock and camera action. Correction in angle readings had to be made because of elliptical distortion of the clock face due to the clock being set at an angle to the camera. Further check of the regularity of clock action was made from motion pictures of the clock when it was directly facing the camera and from still pictures of the clock in action. Both studies indicated that the clock action was regular, with noted discrepancies well within the range of possible measurement errors.

Angles of movement of the clock hand and velocity scores for all of the throwing trials of the 42 subjects were obtained by measurement from tracings of microfilm projection of the motion picture film. Consistency of both time and distance measurement using this tracing scheme was checked by making independent second tracings of the first overhand softball throwing trial for all 42 subjects. Consistency coefficients of .93 for time measurement and .99 for distance measurement indicated the adequacy of the tracing and measurement procedures.

Measurement of the moment-arms for acting levers was made from tracings of the thrower at the frame of release, when the film was projected by means of microfilm reader (Figure I). A careful estimate of the proper location of the three axes of rotation on the tracing was made by the researcher. Measurement was in centimeter units. Front-view pictures were used for measurement of trunk lever moment-arms for both throws and for the hand lever for the overhand throw. Side-view pictures were used for measuring the arm lever in both throws and the hand lever in the underhand throw.

The observer's consistency of moment-arm tracing measurement was checked by making second tracings of the side and front views at the frame of release. A total of 45 tracings for each type of throw was made. Results shown in Table 1 indicate a satisfactory consistency for the measurement of the trunk and arm levers.

Segment length measures were obtained by standard anthropometric procedures or by approved substitute techniques. Instruments used included large

[3] The timing device was developed and constructed by Robert W. Green, Physics Department, Morningside College, Sioux City, Iowa.

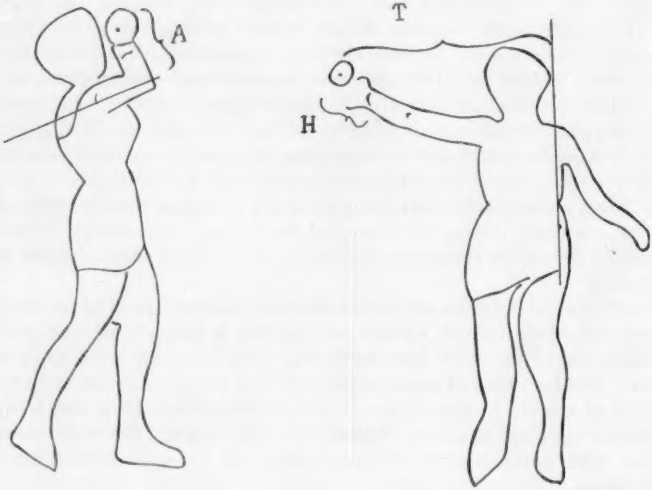

FIGURE I. Overhand throw: front and side view tracings for moment-arm measures. A—moment-arm for arm lever; T—moment-arm for trunk lever; H—moment-arm for hand lever.

TABLE 1.—RELIABILITY COEFFICIENTS FOR MOMENT-ARM MEASURES FOR OVERHAND AND UNDERHAND THROWS

Overhand Throws (N 45)	r
Trunk	.99
Arm	.97
Wrist	.77
Underhand Throws (N 45)	
Trunk	.99
Arm	.95
Wrist	.56

sliding calipers and an anthropometer. The entire set of measurements was taken twice for each subject with a brief interval between the test and its repetition for the same subject. Calculation of the consistency of measurement of the experimenter was made on all structure length measures using the two trials and the difference method of calculating reliability. Results of the consistency calculations are shown in Table 2.

Statistical Treatment of Data. Throwing velocity scores obtained from film measurement of the two types of throws of three groups of subjects using two balls and two trials with each ball were studied by an analysis of variance

TABLE 2.—RELIABILITY COEFFICIENTS OF STRUCTURE LENGTH MEASURES USING MEASURE-REMEASURE PROCEDURES WITH 45 SUBJECTS

Structure Measures	r	Structure Measures	r
Hand	.96	Trunk Height	.96
Shoulder	.94	Leg Length	.96
Pelvis	.98	Upper Arm	.88
Foot	.99	Forearm	.93
Stature	.99	Thigh	.92
Sitting Height	.96		

procedure similar to that used by Block, Levine, and McNemar (2). The procedure permits the breakdown of sources of variation into sections related to variance due to individuals, to groups, to variables, and to their interaction effects.

Results of the preliminary analysis showed that the original grouping on the basis of overhand throw velocity scores did not hold for the other three throwing events. The F values for the Group x Throw and Group x Throw x Ball were significant well above the 1 percent level and the F value for Group x Ball was close to being significant at the 5 percent level. There were systematic differences between groupings on the basis of type of throw and type of ball.

As a result of these findings, separate velocity groups were arranged for the softball overhand, softball underhand, baseball overhand, and baseball underhand throws. The reorganization of groups for each throw was accomplished by forming three velocity groups of 14 subjects each using the throwing velocity records obtained by film measurement of each of the four throws.

Variance between the three velocity groups on the acting lever moment-arm measures and on the structure length measures was analyzed separately for each of the four throws so that eight analyses were made using the Block, Levine, McNemar scheme of analysis. Sums of acting lever variables for the overhand throw found as part of the analysis are given in Table 3.

TABLE 3.—SUMS OF ACTING LEVER MOMENT-ARMS BY VELOCITY GROUPS FOR TRUNK, ARM, AND HAND LEVERS MEASURED AT MOMENT OF RELEASE OF BALL FOR OVERHAND THROWS WITH SOFTBALL AND BASEBALL

		Acting Lever Moment-Arms		
Group	Throw	Trunk	Arm	Hand
A	SO	27.30	20.00	7.95
	BO	26.65	19.30	7.90
B	SO	31.85	19.60	7.50
	BO	30.60	18.35	7.00
C	SO	33.55	17.80	7.65
	BO	33.10	17.30	7.05

Since velocity scores were used only for assigning subjects to one of the velocity groups for a given throw, it was not possible to use analysis of variance mean squares to estimate the proportional contribution of different lever components to the total velocity variance. An approach to the solution of this problem was made by calculating coefficients of correlation between acting lever moment-arms and the velocity achieved with each type of throw. Correlation coefficients were calculated separately for each velocity group and were then pooled to form a total coefficient for each acting lever moment-arm. Results are shown in Table 4.

TABLE 4.—CORRELATIONS BETWEEN THROWING VELOCITY SCORES AND ACTING LEVER MOMENT-ARM MEASURES BY GROUPS FOR THE OVERHAND THROWS

	Softball Overhand		Baseball Overhand	
	r	r^2	r	r^2
Trunk Lever				
Group				
A	.35	.12	.25	.06
B	—.32	.10	.008	.00
C	.26	.07	.48	.23
A-B-C	.44	.19	.49	.24
Arm Lever				
Group				
A	—.16	.03	.09	.00
B	—.23	.05	.002	.00
C	—.24	.06	—.45	.20
A-B-C	—.36	.13	—.33	.11
Hand Lever				
Group				
A	—.15	.02	.39	.15
B	—.53	.28	—.07	.00
C	—.33	.11	—.40	.16
A-B-C	—.26	.07	—.36	.13

Results

Overhand Throw. Results of the analyses of lever variables were similar for the softball and baseball overhand throws, as may be noted in Table 3.

1. Consistency of the measurement of velocity scores was determined from results of the preliminary analysis of variance. Nonsignificant F values for all of the trial terms in the analysis indicated that a satisfactory consistency of throwing velocity scores was obtained by using the film measurement method for the two types of balls and two types of throws.

2. For the moment-arm measures the Group/Individual F was not significant, i.e., group differences were not significantly greater than the observed individual differences.

3. Evidence of interaction effects for the moment-arm variables may be observed in Table 3 where there are definite shifts in the size and direction of differences between the sums of acting lever moment-arms for the three velocity groups. The analysis of variance showed that these shifts were large enough to be significant, since the F value for the Group x Variable/Individual x Variable was significant at about the 1 percent level. Thus, there was demonstrated here a pattern of lever contribution to throwing velocity.

4. Study of the sums of moment-arms by groups (Table 3) indicated the nature of this pattern—the best throwing velocity was achieved by subjects who had the longest moment-arm for trunk rotation and the shortest moment-arm for medial rotation of the arm at the moment of release of the ball.

5. Neither the Group/Individual nor the Group x Variable/Individual x Variable F was significant for the structure length measures. There was no apparent pattern of structure length contribution to throwing velocity. Results of the analysis of structure length measures indicated, further, that the significant Group x Variable interaction found in the acting lever moment-arm analysis was not a simple function of body segment length.

Results of the calculation of coefficients of correlation (r) and determination (r^2) for the overhand throws were also similar as may be noted in Table 4. The size of the correlation coefficients may be said to give some indication as to the importance of each respective acting lever moment-arm in determining the velocity scores for a particular throw. This use of the correlation coefficient is mentioned by Guilford (5).

1. Correlation coefficients of .44 and .49 for trunk moment-arms, with the softball overhand and baseball overhand throwing velocities respectively, indicated that the length of the trunk lever at the moment of release of the ball had considerable predictive power relative to the throwing velocity which was achieved by these subjects.

2. Correlation coefficients of —.36 and —.33 for the arm lever moment-arm with the same two throws indicated that the length of the arm lever also had predictive power relative to the throwing velocity which was achieved.

The squares of the obtained correlations (r^2), as shown in Table 4, were interpreted as an indication of the contribution of acting lever lengths to the throwing velocities achieved. In mentioning this interpretation of correlation McNemar (9) states that the square of the correlation coefficient gives the proportion of total variance of Y which is predictable from X, or r^2 measures the proportion of the Y variance which can be attributed to variation in X.

From Table 4 it may be noted that for the softball overhand throw the pooled trunk lever correlation coefficient of .44 becomes .19 when squared. Moving the decimal point makes possible an interpretation in terms of percentage which permits the statement that 19 percent of the velocity variance may be accounted for by variation in trunk lever moment-arms.

Use of the coefficient of determination (r^2) as an estimate of the percentage of velocity variance which might be accounted for in terms of the three acting lever moment-arms indicated the following:

1. 19 percent of the softball overhand velocity variance and 24 percent of the baseball overhand velocity variance could be accounted for in terms of the acting lever moment-arm variance.

2. 13 percent of the velocity variance for the softball overhand throw and 11 percent of the velocity variance for the baseball overhand throw could be accounted for in terms of the acting arm lever moment-arm variance.

3. 7 percent of the velocity variance for the softball overhand and 13 percent of variance for the baseball overhand throw could be accounted for in terms of the acting hand lever moment-arm variance. It should be noted that hand lever results may be of less value here than are the trunk and arm lever results. Because of the difficulty of measurement of the hand lever, the consistency coefficient was .77 for the softball overhand throw.

Underhand throw. With the underhand throws there was no significant Group/Individual or Group x Variable/Individual x Variable F value for either softball or baseball throws. These nonsignificant results held for both acting lever moment-arm and structure length analyses.

Thus, results of the analyses showed that for the underhand throws with these subjects acting lever moment-arms did not distinguish between groups established on the basis of throwing velocity. The same finding held true for the structure length measures. Evidently neither the length of body segments nor the position of the acting levers at the moment of release of the ball was a critical factor in determining the velocity with the underhand throws.

Discussion of Results

These findings provide evidence that differences in the way in which the body segments were being used at the moment of release of the ball did make a substantial difference in the ball velocity which was achieved with the overhand throw. Results seem to indicate that with the subjects in this study and with the moment-arm data taken at the moment of release of the ball a position of body segments permitting the greatest range of the trunk rotation action and the least range for medial rotation of the arm favors the achievement of better overhand throwing velocity scores.

Apparently with these subjects the trunk rotation action is of more importance in the force producing phase of the movement than has commonly been recognized. Further study is needed to explain the possible advantage of the short moment-arm for medial rotation of the arm. It has been assumed that medial rotation of the arm makes a major contribution to the velocity achieved with the thrown ball in an overhand throw. Observation of the film records of all subjects demonstrated a preliminary arm position which would

permit medial rotation of the arm as one of the major actions contributing to the throw.

Results of observation of the tracings of subjects achieving the extremes in overhand throwing velocity suggest two possible approaches to further study of the arm lever action. It seems possible that differences in elbow action may provide part of the explanation for the advantage of the short moment-arm measures found to be associated with better velocity achievers. It appeared that some extension of the arm at the elbow joint was observable with all the better throwers, while the majority of the members of the low velocity group held their forearm more nearly at right angles to the upper arm at the moment of release. Some degree of elbow extension at the frame of release would help to explain both a longer trunk lever and a shorter medial rotation arm lever. Extending the forearm to the side (one pattern) would increase the length of the trunk lever moment-arm which was measured from the hip joint to the center of the ball at the moment of release. Extending the arm either sidewards or upwards (a second pattern of extension) would decrease the length of the medial rotation moment-arm which was measured as the perpendicular distance from the axis of rotation to the ball.

It seems likely that study of differences in angle between forearm and upper arm at the moment of release and the relation of these differences to the achieved velocity might be profitable. Further study of the timing of the throw aimed at discovering the time during the throwing pattern at which medial rotation of the arm is most important also would be helpful.

Conclusions

1. There was demonstrated with these data a pattern of lever contribution to overhand throwing velocity when the velocity-lever relationship was defined in terms of the correlation of the respective acting lever moment-arms of the trunk, arm, and hand levers with the velocities achieved in the overhand throws.

2. The sizeable coefficients of correlation and determination (r^2) obtained between velocity and moment-arm scores for the overhand throws gave some indication with this group as to the importance of each acting lever in determining the velocity score and as to the proportion of variance in velocity that was associated with variation in the moment-arm measures.

3. The size of the correlation coefficients offered evidence that the moment of release of the ball is at least one of the critical times during the throwing pattern for studying and measuring lever action in the overhand throw.

4. The sizable coefficients of correlation between moment-arms and velocities found with the overhand throws did not hold for the underhand throws.

5. Results with structure length measures showed that it was not possible to distinguish between either overhand or underhand throw velocity groups on the basis of scores for any of the structure length variables.

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Relationship between Body Types and Static Posture of Young Adult Women[1]

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Abstract

This investigation was designed to determine the relationship between body type and body alignment and center of balance. Data were collected from 58 women students at Washington State University. Each subject was classified into body type components of endomorphy, mesomorphy, and ectomorphy. The methods used for measurement were Sheldon's technique for somatotyping, a modified technique of Howland's alignometer for body alignment, and the Lovett-Reynolds technique for determining the center of balance. Statistically, somatotype was not significantly related with body alignment or with the center of balance. However, significant correlations were found to exist between height and trunk length measures and between a ratio of trunk measures and body alignment ($P<0.01$).

EARLY ATTEMPTS TO evaluate postures were in the nature of discovering a standard of excellence to which all persons should conform (1). Understanding the problems involved in attempting to find a simple and accurate process for measuring a standard posture, Goldthwait was of the opinion "that there is not and cannot be one posture which is normal for all individuals and to which all individuals should conform" (6). The curiosity of the writer concerning body build and posture was aroused in an article by Goff (5) who found that only the muscular in body build represented the so-called ideal posture, and that other types cannot assume such a stance without strain. His results were in general agreement with those of Goldthwait and others (11). As indicated by the literature, the variety of postures commonly seen may be due to a relationship between posture and body build. Possible body build and segmental alignment of the body are related, and so can be evaluated according to an alignment technique based on the mechanics of balance. Such an instrument, known as the alignometer, was developed by Howland (7). This mechanism measures vertical alignment between the center of the sternum and the symphysis pubis, and trunk balance from designated horizontal points to body landmarks.

When a postural position is assumed by any body type, the gravital pull on the body must be counterbalanced by alignment of body parts through muscular action. Realizing the importance of the center of gravity in body static and dynamic posture, Reynolds and Lovett developed a technique using a

[1]This study was made in partial fulfillment of requirements for the degree of Master of Science in Physical Education at the Washington State University, 1959, under the direction of Virginia Shaw and George Hearn.

weight scale to measure the gravital line at the base of support in the anterior-posterior plane (9).

When referring to the body mechanics of posture, it is recognized that careful consideration must be given to body build, body alignment, and the gravital line of the body (12). No reference was found correlating these relationships in young adult college women. This lack of information provided the impetus for this study.

Statement of the Problem

The purpose of this investigation was to determine if there is a relationship between the constitutional body type and the static postures of young adult college women. The subproblems were (a) to determine body type by somatotyping, (b) to designate the center of balance, (c) to establish body alignment during static erect posture, and (d) to investigate the relationship of body type with body alignment and with the center of balance.

Procedures and Types of Data Collected

The subjects participating in this investigation were 58 volunteer, young, adult, college women at the Washington State University. There were 27 subjects either majoring or minoring in physical education; the remaining 31 had various other majors. The subjects had a mean age of 20.15 years, a mean height of 65.6 inches, and a mean weight of 139 lbs.

The data were collected in the Physical Education Research Laboratory at the State College of Washington. Three different measurements were taken on each subject: (a) each individual was somatotyped according to instructions from W. H. Sheldon, who also evaluated the photographs, (b) the center of balance was determined utilizing the Lovett and Reynolds technique, and (c) body alignment was taken by utilizing the modified Howland alignometer.

Sheldon's technique (10) of somatotyping secures three photographic views (frontal, lateral, and dorsal). During the somatotyping procedure correct positioning of each subject in each view was of paramount importance. In addition to the photographs, data concerning personal age, height, and weight were necessary. This information combined to designate body type.

The Lovett and Reynolds technique for determining the center of balance was used in this study because of the simplicity and reliability of method. The measuring device consisted of a flat board approximately 2 cm. in thickness, 28 cm. in width, and 55 cm. in length. It was supported at each end on a knife edge which was located 2.5 cm. from either end of the board. One knife edge was placed on the center of the platform of a calibrated bathroom-type scale and the other knife edge was supported by a wooden block the same height as the scale. A straight line was drawn parallel to the knife edge 15 cm. from the knife edge resting on the block. A sliding T-square was placed on this line so that the heels of the subject would be located in the same exact place. Weight of the board on the scale was recorded. Then the subject stood on the center of the board facing the scale with the heels against the T-square.

A reading was taken when the needle of the scale no longer fluctuated. When repeated, if the first two readings were identical no further measurement was made. If there was disagreement, a final reading was recorded and the three averaged. A formula was then used to find the individual's center of balance.

The modified alignometer consisted of four arms and pointers which were adjusted both vertically and horizontally from a vertical steel rod with a wooden base. Both the vertical and horizontal adjustments were calibrated in millimeters. The subject stood facing the perpendicular rod with the heels resting at the posterior edge of the base. The wooden pointers were adjusted to the various anatomical landmarks and those distances were noted and recorded. The sternal landmarks touched by the pointers are as follows: the interclavicular notch, the center of the sternum, and the inferior tip of the xiphoid process. The other pointer was extended to the superior border of the symphysis pubis sterno-pubic line was noted and recorded. Final measurements for individual body alignment were taken when the pointers at the center of the sternum and the superior border of the symphysis pubis were extended horizontally to touch these anatomical landmarks. Three separate readings were taken on each subject due to the element of the forward and backward body sway while standing and the possible variable pressure applied by the administrator with the sliding pointers. If the first two readings were the same, the measurement was final; if none of the readings were the same, then three readings were averaged. Body alignment was said to exist if the pointers were equal distances at the sterno-pubic landmarks from the rod to the body.

Foot length measurements were taken when it was realized that the length of the foot might be a factor in body alignment. This measurement was secured through correspondence. Measurement was taken by drawing around the feet on a sheet of paper. The lengths of the feet, measured in centimeters, were averaged and the center of balance located.

Results

Statistical treatment of the data revealed a significant relationship between ectomorphy and height ($P<0.01$), between ectomorphy and the length of the sternum ($P<0.05$), and ectomorphy and the sterno-pubic line ($P<0.01$). There was also revealed a significant relationship between height and trunk length measures ($P<0.01$). Endomorphy showed a significant relationship between height and trunk length measures ($P<0.01$). Endomorphy showed significant relationship to weight ($P<0.01$), while mesomorphy and ectomorphy did not. Constitutional body type was not significantly related to either body alignment or the center of balance for these subjects. Neither the length of the foot nor the point where the center of balance fell in foot length was significantly associated with body alignment. A very significant relationship was found between the ratio (b to a) of the length of the sterno-pubic line to the length of the sternum ($P<0.01$) and

TABLE 1.—MEANS, STANDARD DEVIATIONS, AND CORRELATIONS AMONG VARIABLES

	1[b]	2	3	4	5	6	7	8	9	10	11
N = 58[a]											
Mean	163.93	139	5.7	2.9	3.62	12.63	8.68	16.05	40.79	2.57	2.13
SD	5.93	1.6	0.8	0.8	0.9	0.55	1.37	1.78	3.25	0.3	1.48
1. Height[c]	———	.331	—.238	.124	.694	.553	.266	.419	.514	—.011	—.265
2. Wt. in pounds		———	.537	—.271	—.157	—.459	.272	.162	.201	.057	—.191
3. Endomorphy			———	—.073	—.595	—.905	—.002	—.099	—.271	—.111	—.046
4. Mesomorphy				———	—.320	—.203	—.085	—.226	.311	.062	.251
5. Ectomorphy					———	.788	.178	.337	.350	.073	—.080
6. Sheldon's Ponderal Index						———	.123	.244	.011	.081	—.026
7. Center of Balance							———	.004	.174	.099	.034
8. Length of Sternum (a)								———	.070	—.728	—.381
9. Sterno-Pubic Length (b)									———	.399	—.077
10. Ratio (b) to (a)										———	.402
11. Body alignment											———
N = 51[d]							8.20				
Mean							1.80				2.03
SD							.221				1.56
Foot length		Mean = 24.61			SD = 1.09						—.126

[a] .261 and .338 significant at .05 and .01 levels of confidence, respectively.
[b] Correspond and denote vertical numbers and variables.
[c] All linear measurements are taken in centimeters.
[d] .273 and .354 significant at .05 and .01 levels of confidence, respectively.

body alignment ($P<0.01$). Table I summarizes the results and gives composite information on the data found in this study.[2]

Discussions and Conclusions

Within the limitations of this study, the following conclusions are made:

1. Somatotype for young adult women is not related to body alignment as measured by the modified Howland alignometer. Since other studies (5, 6) have found significant relationships between body type and body alignment in men, the reason that similar results were not found in this study for women may have been due to the relatively small number of subjects and the nature of the sample involved.
2. Somatotype for a small sample of young adult women does not have a significant relationship with the point where the line of gravity falls at the base of support and, therefore, substantiates similar results found on men (2, 3).
3. Data relative to the point where the line of gravity passes through the foot substantiate the results of other investigators (4, 6, 8, 11).
4. When considering postural standards for women, height, the sterno-pubic line, and the length of the sternum may be factors, while the length of the foot is not.

Recommendations

Additional knowledge in the area of posture, body alignment, and somatotype for women is needed. The following recommendations are made: (a) more data should be collected on women subjects with regards to somatotype and body alignment (measurements might augment or reveal different results); (b) additional information is needed on the height factor with regards to body alignment; (c) more research on the weight distribution as related to posture of women is needed; and (d) a ten-year follow-up study on the somatotype classification of the subjects used in this study might show specific indications of somatotype carry-over in the more mature years of these subjects and indicate the existence of a consistency in the somatotype classification.

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Status of the Physical Education Required or Instructional Programs in Four-Year Colleges and Universities

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Abstract

The purpose of this study was to determine the status of the required physical education program for men and women in the four-year colleges and universities of the United States as of June 1958, with respect to the areas covered by the Washington Conference on Physical Education. Tabulated data represent replies from 168 department chairmen, in most instances. The findings show that practices related to philosophy and objectives, administration, program, and evaluation in different types of colleges and universities are usually quite similar. When chi square was used to test 37 null hypotheses only four significant differences were discovered. It appears, therefore, that the principles developed at the Washington Conference seem to apply to all four-year college required programs of physical education.

IN OCTOBER 1954, the American Association for Health, Physical Education, and Recreation served as host to a conference in Washington, D. C., on the topic of physical education for college men and women. The College Physical Education Association and the National Association for Physical Education of College Women were the other two cooperating associations. This conference was the direct result of a need for a national meeting to establish principles and guides for physical education programs. A report of the findings of this conference was published early in 1955.

To ensure follow-up of the conference work a Joint Committee on Physical Education Programs for College Men and Women was appointed. Three members from each of the three sponsoring organizations make up this committee. This study was sponsored by the three associations under the direction of the chairman of the Joint Committee.[1]

Purpose of the Study

This study was concerned with determining the status of instructional physical education programs for men and women in the four-year colleges and universities of the United States as of June 1958. Changes in practices since 1954 were summarized. An attempt was made to determine if any

[1]Harold Cordts conducted the study as a doctoral dissertation at Syracuse University under the guidance of John H. Shaw.

significant differences existed between practices in state coeducational, private coeducational, men's and women's colleges.

Procedures

After a careful review of the literature a questionnaire was developed based largely on the criteria included in the Washington Conference Report of 1955. Before its use, the questionnaire was studied by a number of persons including a working group of the participants in the preconvention Workshop on College Physical Education for Men and Women held in Kansas City at the national convention of the AAHPER in April 1958.

The data for this study were obtained from the chairmen of required or instructional physical education programs at state coeducational, private coeducational, men's, and women's colleges in the United States. A random sample of 300 institutions was drawn from the listings in *American Universities and Colleges* of 1956.[2] Questionnaires were sent to 150 chairmen of the women's required programs and to 150 chairmen of men's required programs. With 79 women and 105 men responding, an over-all return of 184 (61⅓%) was received. As 16 (8.6%) of the responding chairmen indicated that no programs were in operation, the actual number used for the purpose of reporting was 168.

Approximately 80 percent of the colleges and universities represented in this study had enrollments under 3000. Six percent of the institutions enrolled over 10,000 students. Institutions from 42 states and the District of Columbia were represented.

The chi square test was employed to test for significant differences between practices in physical education departments at different types of institutions. Data were presented in terms of the frequency of occurrence of the yes and no responses. A correction for continuity was utilized when working with one degree of freedom or when the expected frequency in any cell was less than five. Thirty-seven null hypotheses were so tested.

Before any responses were obtained from participants in the study, 19 questions were selected to be answered yes or no and upon which it was wished to identify any significant differences in practices between different types of institutions. First, the responses were considered in terms of men's departments in state coeducational, private coeducational, and men's colleges. Second, the responses were considered in terms of women's departments in state coeducational, private coeducational and women's colleges—however, as one item did not apply to women's departments, the total tested was 37. Seven hypotheses pertained to questions under the administration area (Items 8, 42, 45, 47 [only men], 48, 55, 59). Four hypotheses were tested under the philosophy and objectives area (Items 1, 3, 4, 5). Four hypotheses were also tested relative to the program area (Items 2, 6, 7, 9) and the evaluation area (Items 4, 7, 13, 16).

[2]Special schools listed as conservatories and seminaries and West Point and Annapolis were the only ones eliminated from the listing.

The majority of the items in the questionnaire were formulated on the basis of the criteria included in the Washington Conference Report. The status of these programs is therefore reported under the four subdivisions included in this report.

Summary of Findings

The following is a condensed summary of the questions and findings:

Philosophy and Objectives

1. Has the educational philosophy of your department been formulated in writing? Yes—82%; No—18%.

2. To what extent has your instructional staff subscribed to the above mentioned philosophy? 90-100%—50%; 80-89%—19%; 70-79%—7%; 60-69%—3%; 50-59%—2%; NR[3]—19%.

3. Is your philosophy in harmony with the over-all educational philosophy of the college or university as stated in the appropriate publications of the institution? Yes—93%; No—2%; NR—5%.

4. Have the objectives of the required physical education program been formulated in writing? Yes—82%; No—16%; NR—2%.

5. Are these objectives compatible with the over-all educational philosophy of the department and the institution? Yes—86%; No—1%; NR—13%.

6. In which of the following areas have you listed objectives? Effective movement—49%; Human relations—66%; Skill in specific activities—82%; Physiological function—62%; Knowledges, insights, and understandings—80%; Appreciations—74%.

7. Have any changes been made by your department which pertain to this general area—philosophy and objectives—since 1954? Yes—36%; No—56%; NR—8%.

8. Was the Washingt. n Conference one factor influencing these changes? Yes—13%; No—48%; NR—39%.

Summary and Interpretations of Reported Changes in the Philosophy and Objectives Areas Since 1954

Department philosophies have been formulated in writing and correlated with the general college philosophy. Statements of objectives have been clarified with resulting increased emphasis being placed on certain areas such as fitness, body mechanics, health principles, and carry-over sports. Changes have not been uniformly in the same direction. For example, while some schools mentioned moving toward more emphasis on physical fitness, others mentioned moving away from it to a more balanced program. There was some mention of greater emphasis being placed on an intellectual approach to the principles of movement.

Administration

1. In developing your program of physical education, are you committed to action through a democratic process which includes the required physical education faculty? Yes—77%; No—14%; NR—9%. Students? Yes—45%; No—37%; NR—18%.

2. Does your department interpret a broad concept of physical education to the general faculty? Yes—66%; No—18%; NR—16%. Students? Yes—88%; No—4%; NR—8%. Administration? Yes—86%; No—7%; NR—7%. Community? Yes—35%; No—38%; NR—27%.

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[3]NR = no response.

3. Do physical education staff members participate on usual campus committees? Yes—92%; No—2%; NR—6%.

4. What means are used to interpret physical education to students, faculty, and the community? Written materials—70%; Special events—80%; Bulletin boards—85%; Community activities—34%; School organizations—69%; Citizens committees—8%; Newspaper, radio, and TV—58%.

5. To whom is the chairman of the department directly responsible? President of the institution—27%; Dean of the college—17%; Director of physical education and athletics—16%; Others varied among the following: Dean of Instruction; Chairman of the Division of HPER; Dean of the School of Education.

6. In what percent of institutions does the immediate superior of the chairman of required physical education have responsibility for the following problems of both men and women? Policy—80%; Budget—72%; Equipment—62%; Facilities—71%; Intramural programs—43%; Coeducational activities—53%; Scheduling of classes—66%.

7. Does your institution have established standards relative to the following? Staff qualifications—90%; Teaching load—80%; Size of classes—62%; Retirement—87%; Academic rank—87%; Salaries—79%.

8. Do the above standards apply equally to staff members on the required physical education staff? Yes—85%; No—10%; NR—5%.

9. What percent of the staff teaching required physical education classes are the following? Professors—29% in 2/5 of departments; Associate Professors—27% in 3/5 of departments; Assistant Professors—35% in 2/3 of departments; Instructors—43% in 2/3 of departments; Graduate Assistants—18% in 1/7 of departments; Undergraduate student majors—44% in 1/7 of departments; Others—38% in 1/10 of departments.

10. What percent of the required physical education sections are taught each term by the following: Professors: 25% in 1/3 of departments; Associate Professors—28% in 3/5 of departments; Assistant Professors—44% in 2/3 of departments; Instructors—51% in 2/3 of departments; Graduate Assistants—13% in 1/7 of departments; Undergraduate student majors—11% in 1/10 of departments; Others—16% in 1/13 of departments.

11. How many teachers of required physical education classes have the following as the highest degree obtained? Doctor's Degree—24% in 1/3 of departments; Master's Degree—65% in nearly all departments; Bachelor's Degree—36% in 2/3 of departments; A degree but no major in physical education—31% in 1/6 of departments; No degree at all—29% in 1/9 of departments.

12. How is teaching load determined in your department? Clock hours per week—37%; Credit hours—26%; Lab-lecture equation of 3 to 1—4%; Lab-lecture equation of 2 to 1—22%; Weighted load based on analysis of duties—39%.

13. What is the accepted average teaching load of all teachers on your campus? 13.6 clock hours per week. What is the average teaching load of your teachers in the required program? 15.3 clock hours per week.

14. What percent of your required physical education classes range in enrollment from 25-35?—45%; Are under 25?—38%; Are over 35?—17%.

15. Are salaries of required physical education staff members the same as other staff members of similar rank? Yes—83%; NR—17%.

16. Does your department promote continuous inservice education? Yes—51%; No—23%; NR—26%.

Rank inservice procedures most often practiced by your staff members. 1. Staff meetings; 2. Professional conferences; 3. Study; 4. Travel; 5. Research; 6. Professional writing.

17. How frequently do you hold staff meetings for required physical education personnel? Once a week—17%; Twice a month—11%; Once a month—36%; NR—36%.

18. Generally, how long are these meetings? I hour (51%).

19. Do persons from the following areas normally attend? Intramurals—71%; Teacher Education—54%; Community Recreation—21%; Campus Health Service—12%; Intercollegiate Athletics—59%.

20. What percent of required departments utilize the following off-campus facilities in conducting their program? Golf course—52%; Swimming pool—18%; Bowling alley—41%; City Park—23%; CYO facilities—1%; YMCA facilities—12%; YWCA facilities—7%; Red Cross facilities—12%; Jewish Community Center—1%; Other—3%.

21. What activities commonly offered in the required physical education program are *not* offered in the Intramural Program? Dancing, Golf, Gymnastics, Tumbling, Aquatics, and Archery were the sports most frequently mentioned.

22. What activities commonly found in the Intramural Program are *not* offered in the required physical education program? Bowling, Softball, Table Tennis, Touch Football, Track and Field were the sports most frequently mentioned.

23. What percent of required physical education staff members are engaged in the following? Intramural activities—46% in almost all departments; Intercollegiate activities—62% in 3/4 of departments; Teacher education activities—55% in 2/3 of departments; Campus recreation activities—45% in 2/3 of departments.

24. What percent of departments use various facilities to conduct their programs and what percent classified these facilities as adequate (shown in parentheses)? Archery Ranges—65% (39%); Badminton Courts—89% (61%); Baseball Diamonds—45% (36%); Basbetball Courts—93% (64%); Bowling Alleys—35% (20%); Boxing Rooms —18% (12%); Cross Country Courses—18% (15%); Dance Studios—43% (18%); Fencing Rooms—20% (10%); Field Hockey Areas—48% (28%); Football Fields—57% (44%); Golf Courses—43% (18%); Gymnastics Areas—63% (35%); Handball Courts—35% (19%); Horseback Riding Areas—9% (7%); Horseshoe Pits—27% (21%); Ice Rinks—10% (7%); Lacrosse Fields—12% (8%); Ski Slopes—8% (5%); Soccer Fields—60% (36%); Softball Fields—86% (55%); Speedball Fields—49% (30%); Squash Courts—13% (7%); Swimming Pools—74% (47%); Tennis Courts—86% (52%); Track and Field Areas—54% (45%); Volleyball Courts—92% (72%); Wrestling Rooms—42% (22%).

25. Is the source of financial support for the required physical education program the same as for the other instructional areas of the institution? Yes—89%; No—5%; NR—6%.

26. Is there a separate budget for each of the following? Required physical education—Yes—40%; Intercollegiate athletics—Yes—58%; Recreational activities—Yes—26%; Teacher Education—Yes—18%; Intramural athletics—Yes—39%.

27. Is physical education required of all undergraduate students? Yes—67%; No—23%; NR—10%.

28. Do all departments or colleges on your campus have a similar physical education requirement? Yes—74%; No—12%; NR—14%.

29. How many terms are required of undergraduate men? Two—15%; Three—5%; Four—46%; Six (semesters)—6%; Six quarters—7%; Five or eight semesters, or three, four or five quarters—9%; NR—12%.

30. How many terms are required of undergraduate women? Two—11%; Three—6%; Four (semesters)—56%; Six quarters—10%. One, five, six, or eight semesters, or three, four, or five quarters—11%; NR—6%.

31. What percent of departments permit a student to be exempt from physical education for the following?: Veteran's experience—38%; Intercollegiate sports—31%; Proficiency tests—20%; Medical reasons—65%; ROTC—13%; Band—7%; Age—32%; Other—3%.

32. How many credits are granted for successful completion of each term of physical education? One quarter or one semester hour—53%; Two semester hours—2%; ½ quarter or ½ semester hour—4%; NR—41%.

33. Are grade points earned on this credit granted on the same basis as for any other area in the educational program? Yes—58%; No—32%; NR—10%.

34. Do these grade points count toward graduation? Yes—61%; No—27%; NR—12%.

35. Do these grade points count toward honors? Yes—53%; No—33%; NR—14%.

36. May students elect to take physical education beyond the required terms and earn credit toward graduation? Yes—44%; No—46%; NR—10%.

37. Are required physical education credits counted within the total hours necessary for graduation? Yes—69%; No—22%; NR—9%.

38. Required physical education classes meet how many times per week? Two periods —61%; Three periods—31%; Other—8%.

39. What is the average total weekly meeting time? 119 minutes.

40. What is the length of the typical period, exclusive of shower and dressing time? Average = 38 minutes.

41. What is the length of the period, including shower and dressing? Average = 53 minutes.

42. Are all entering students given a thorough medical examination by a home or staff physician prior to participation in the required physical education program? Yes—93%; No—4%; NR—3%.

43. Is this examination followed by other examinations? Yes—40%; No—46%; NR—14%.

44. Are health service personnel familiar with the required physical education program? Yes—86%; No—8%; NR—6%.

45. How are health service personnel familiarized with the physical education program? Attendance at physical education staff meetings—10%; Written syllabus of the physical education program—28%; Regular discussion with the physical education staff —54%; Written memos from the physical education department—55%; Committee meetings—29%.

46. Is the policy concerning adaptation of, or permanent exemption from, participation in the required physical education program for medical reasons based on the judgment of the following? Medical staff—55%; Physical education staff—6%; Both—38%.

47. Are students permitted to substitute freshman and varsity sports in season for the purpose of meeting their physical education requirements? Yes—46%; No—48%; NR —6%.

48. Does your department provide all equipment essential to participation in all activities in the required physical education program? Yes—62%; No—35%; NR—3%.

49. Are students provided complete gymnasium suits, except tennis shoes? Yes—10%; No—86%; NR—4%.

50. Are students required to purchase a prescribed gymnasium suit? Yes—75%; No—20%; NR—5%.

51. For the use of suits, towels, or equipment students must: Pay a fee each term—29%; Make a deposit which is returned—10%; Pay no fee or deposit—37%.

52. Each student receives: An individual basket—30%; An individual locker—53%; NR—17%.

53. If the department launders towels, how often are they changed? After each use—52%; Weekly—5%; NR—43%.

54. Is storage space for all equipment reasonably adequate? Yes—58%; No—30%; NR—12%.

55. Do instructors recognize and execute their responsibility with respect to guidance and counseling of students? Yes—84%; No—4%; NR—12%.

56. How is this guidance and counseling conducted? Individual conference—89%; Referral to experts—51%; Special projects—13%; Special tests—21%; Individual assignments—39%; Group meetings—39%; Committees—4%.

57. Is adequate supervision provided for teaching done by graduate assistants and teaching fellows? Yes—20%; No—10%; No graduate students—27%; NR—43%.

58. What techniques are most often employed in supervising the teaching of graduate assistants? Class visitation—62%; Individual conference—62%; Staff meeting—40%; Professional conference—28% Staff committee work—8%. (Percent here based on N of 50).

59. Are comprehensive and accessible records maintained to indicate student accomplishment within the program? Yes—53%; No—23%; NR—24%.

60. What information is kept on student record forms? Swimming proficiency and classification—47%; Medical examination and classification—55%; High school physical education participation—23%; Testing results and recommendations—42%; Activities taken in college—60%; Activities recommended to be taken—23%; Grade record—51%; Conferences—5%.

61. Do you conduct a program of organized research with the required physical education program? Yes—15%; No—72%; NR—13%.

62. Who actually carries out this research? Research person—19%; Instructor—69%; Department chairman—42%; Staff committee—8%. (Percent here based on N of 26).

63. Have any changes been made by your department which pertain to this area (administration) since 1954? Yes—29%; No—50%; NR—21%.

64. Was the Washington Conference one factor influencing these changes? Yes—7%; No—40%; NR—53%.

Summary and Interpretation of Reported Changes in the Administration Area Since 1954

A number of changes in departmental organization were reported, such as combining the men's and women's departments, a chairman appointed who holds the doctorate, a director of intramurals appointed in addition to a departmental chairman, or a rotating three-year chairmanship established. Another series of changes included such things as an increase in number of well-trained staff members in both men's and women's departments, new facilities, annual medical examinations, required teaching loads clearly defined, improved record systems, and standardized uniforms or towel service. Some things mentioned were actual program improvements which logically belong in the next section and so are not summarized here. Several schools mentioned improved catalog publicity and course descriptions. Seven institutions mentioned improvement in the requirement situation such as from one to two years or two to four years. Others were: veterans no longer excused, age excuse no longer allowed, and positive credit for the required program. In general these changes seemed to indicate improved status for the program.

Program

1. On a four-point scale note the strength of your program areas in terms of the number of activities taught (1-weak; 2-moderate; 3-strong; 4-very strong). Gymnastics and tumbling—ranged from 1 to 2; Rhythms and dance—2; Aquatics—ranged from 4 to 3; Individual sports—ranged from 4 to 3; Body mechanics—1 to 2; Adapted activities—1 to 2; Dual sports—3 to 2; Team sports—3 to 4.

2. Has this emphasis changed since 1954? Yes—36%; No—54%; NR—10%.

Frequent comments about the nature of changes were that directors were placing more emphasis on individual and dual sports, aquatics, and body mechanics as they reported a shift away from many team sports.

3. Does your program make full use of local geography and climate? Yes—74%; No—15%; NR—11%.

4. What percent of departments offer the following coeducational activities? Aquatics—35%; Archery—49%; Badminton—55%; Bowling—37%; Folk dancing—59%; Golf—44%; Horseshoes—12%; Table tennis—29%; Tennis—46%; Volleyball—34%; Skiing—

11%; Social dancing—55%; Square dancing—60%; Softball—10%; Skating—12%; Fencing—5%; Modern Dance—4%.

5. Who teaches the coeducational activities? Instructors from the men's department —16%; Instructors from the women's department—27%; Both of the above concurrently—49%; NR—7%.

6. Do you have a planned sequence which students must follow as they satisfy the physical education requirement? Yes—46%; No—47%; NR—7%.

Brief explanations of the planned sequence revealed that the specific activities varied considerably. A typical reply indicated that all freshmen took fundamentals courses, then sophomores elected others until the requirement was met. No repetition of a course was permitted. Some responses indicated that freshmen were introduced to many activities and developed minimum skills, whereas sophomores chose recreational type activities to prepare for after-college participation. College women often took swimming and dance which would be followed with electives. Men took a swimming course if they could not swim and a physical fitness test. They would elect the remaining credit hours needed. A few chairmen stated that only one program was offered and all students followed it. Others indicated that individual student program variations were permitted as guided by a recommended pattern.

7. Are specific activities, or activities within areas required of all students? Yes—58%; No—35%; NR—7%.

Specific activities required of all college men students frequently were swimming and dual and team sports such as tennis, handball, volleyball, and softball. Some department chairmen outlined their specific activity requirements as swimming, one team sport, two individual or dual sports, and combatives or rhythms. Usually the school year in which these activities were to be taken was designated.

The activity ordinarily set out as a requirement of all college women was swimming. Many departments specified the remaining courses to be taken as either one in body mechanics, one in dance, one in a team sport, or one in an individual or dual sport. In some departments women were required to take one course in fundamentals of movement, one in team sports, and two in individual and dual sports.

8. What percent of your total required physical education sections were devoted to each of the following during the 1957-58 school year? Gymnastics and tumbling—15% in 1/3 of departments; Rhythms and dance—16% in 1/2 of departments; Aquatics—27% in 1/2 of departments; Individual sports—32% in 2/3 of departments; Body mechanics—16% in 1/2 of departments; Dual sports—28% in 1/2 of departments; Team sports—29% in 2/3 of departments; Other—11% in very few departments.

9. Do you provide special sections for students with individual problems? Yes—35%; No—55%; NR—10%.

10. What is the most common name given to those sections? Adapted physical education.

11. How many students were enrolled in these sections in the 1957-58 school year? Average = 33 students.

12. What percent of departments utilize the following methods to orient students in the required physical education program to the purposes, policies, and opportunities in physical education? Orientation week programs—60%; Medical and health examinations

—45%; Handbooks and printed material—58%; Audio-visual aids—23%; Individual conferences—39%; Group conferences—51%; Demonstrations—28%; Lectures—5%.

13. If health education is offered, do instructors in the required physical education program and health education instructors coordinate their teaching? Yes—38%; No—31%; NR—31%.

14. If it is done, how do health and physical education staff members coordinate their teaching? Regular staff meetings—19%; Written memos sent between staff—5%; Committee meetings—14%; Other—8%.

15. Have any changes been made by your department which pertain to this general area (program) since 1954? Yes—18%; No—48%; NR—34%.

16. Was the Washington Conference one factor influencing these changes? Yes—9%; No—37%; NR—54%.

Summary and Interpretation of Reported Changes in the Program Area Since 1954

All of the comments seemed to indicate improved yearly, unit, and/or daily lesson plans for teaching activities and a general broadening of curricular offerings. These usually included more sections of certain activities such as swimming, expansion of the coeducational program, and the addition of certain activities, particularly the carry-over social activities as contrasted to team sports. Dance activities were particularly prominent in this list.

Evaluation

1. How often does your department formally review and re-evaluate objectives of the required physical education program? Annually—59%; Semi-annually—9%; Quarterly, biannually, or continuously—16%; NR—16%.

2. In assigning grades to students, what weight is given the following factors by instructors? Skill—38% in 2/3 of departments; Habits—10% in 1/4 of departments; Attitude 16% in 1/2 of departments; Appreciations—11% in 1/4 of departments; Knowledge and understanding—24% in 3/5 of departments; Attendance—29% in 1/2 of departments; Improvement—17% in 1/13 of departments.

3. In what form is the final grade awarded to students? Letter—74%; Number—4%; S or U—5%; Pass or Fail—15%; Credit 1%.

4. Is the same grading system used for other subjects on your campus? Yes—77%; No—17%; NR—6%.

5. Are general evaluation techniques cooperatively planned by the required physical education staff? Yes—68%; No—21%; NR—11%.

6. Do all staff members follow this plan in assigning grades? Yes—61%; No—14%; NR—25%.

7. Is student status determined by pretesting at the beginning of each term? Yes—15%; No—40%; Sometimes—37%; NR—8%.

8. How is the pretesting done? Written tests—21%; Practical tests—51%.

9. Is status determined at intervals during the course? Yes—61%; No—16%; NR—23%.

10. How is status determined at the termination of the course? Written tests—65%; Practical tests—76%; Rating scales—18%; Other—6%.

11. Do instructors follow up evaluation with guidance for the students who need it? Yes—72%; No—13%; NR—15%.

12. What uses do evaluation measures serve? Rank the following. 1. Grading; 2. Instructional; 3. Diagnosis and guidance; 4. Classification.

13. Does your over-all evaluation of required physical education students lean heavily on objective measurements? Yes—44%; No—33%; NR—23%.

14. Does this evaluation lean heavily on subjective measurements? Yes—33%; No—29%; NR—38%.

15. Which of the following are employed in evaluation? Proficiency tests—48%; Written tests—70%; Instructor judgment—75%; Objective skill tests—69%; Performance scores—60%; Anecdotal report—10%; Rating scales—15%; Other—3%.

16. Are students given the opportunity to evaluate their accomplishments? Yes—23%; No—14%; Sometimes—52%; NR—11%.

17. Are students offered the chance to evaluate teaching effectiveness and course content? Yes—23%; No—15%; Sometimes—52%; NR—10%.

18. Do your instructors use research findings which apply to evaluation? Yes—30%; No—14%; Sometimes—42%; NR—14%.

19. Have any changes been made by your department which pertain to this general area (evaluation) since 1954? Yes—21%; No—47%; NR—32%.

20. Was the Washington Conference one factor influencing these changes? Yes—8%; No—39%; NR—53%.

Summary and Interpretation of Reported Changes in the Evaluation Area Since 1954

The general impression was gathered from comments on changes in this area that some real improvements had been made in certain institutions. A number of schools reported a general study of the problem of evaluation resulting in more extensive use of written or objective tests for grading purposes. Several reported the addition of motor ability or strength tests. Still others reported the development of achievement or motor performance standards.

Several rather extensive changes in grading practices were listed. Many of these apparently involved more precise use of evaluating measures, some change in weighting of items, or a general change in grading policy. All changes reported seemed to be aimed at a more objective and painstaking evaluation of the required physical education offering.

Conclusions and Implications[4]

Judging from the findings of this study, practices related to philosophy and objectives, administration, program, and evaluation in different types of colleges and universities were usually quite similar. Using chi square only four of 37 hypotheses were rejected at better than the .05 level of confidence. Three of these revealed significant differences between men's departments in coeducational, private coeducational, and men's colleges, and only one indicated differences between women's departments in state coeducational, private coeducational, and women's colleges. They were as follows:

1. A larger proportion of men's departments in men's colleges than in state coeducational institutions permit the substitution of freshman and varsity sports for the purpose of meeting the students' physical education requirements.

2. A larger proportion of men's departments in state coeducational than in either private coeducational or men's colleges provide all equipment essential for students to participate in all program activities.

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[4] Only a few general conclusions are listed here for the sake of brevity.

3. A larger proportion of men's departments in state coeducational than in either private coeducational or men's colleges use the same grading system as that used for other subjects.
4. A larger proportion of women's departments in state coeducational than in women's colleges provide special sections for students with individual problems.

More changes were reported as being made since 1954 in the area of philosophy and objectives than in administration, program, or evaluation but relatively few changes were reported in any areas.

As there were so few differences between program practices in different types of institutions, it would seem that the principles set forth by the Washington Conference apply to all programs. The criteria set forth in the Washington Conference Report may therefore be used with considerable confidence in attempting to evaluate programs.

It should be recognized that some of the questionnaire items were leading questions which might tend to load the yes answers. Since the items used in the instrument were taken from the Washington report this was difficult to avoid completely.

(Submitted 4/8/59)

Acquisition of Throwing Skill Involving Projectiles of Varying Weights

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Abstract

This investigation was conducted in order to determine if there were differences in the degree to which accuracy in throwing with the nonpreferred hand was developed when practice with projectiles of varying weights was used during the learning period. The effects of transfer of learning from the throwing of a ball of one weight to performance with a ball of another weight was also studied. The result indicated that practice with a light ball was as effective as practice with a heavier ball in developing skill to throw a heavier ball. Practice with the heavier ball when transferred to the lighter ball did not demonstrate a corresponding effect.

IN MOVEMENTS REQUIRING fineness of coordination and accuracy, the investigators have in the past observed that performance at times appeared to be facilitated when the performer made use of objects somewhat heavier than those he had employed in his regular practice. For example, it has been observed that moderately skilled basketball players have appeared to exhibit greater accuracy when using a basketball heavier than that which was normally used. Golfers have been observed to perform more proficiently when using a heavier pitching wedge after having practiced the movements involved with a lighter nine iron.

This investigation was conducted in a controlled laboratory environment to determine if there were differences in the degree to which accuracy in a novel throwing skill was developed when projectiles of varying weight were used in the initial learning periods. It was a further purpose of this study to explore the effects of transfer of learning from the throwing of light balls to the throwing of heavier balls and conversely.

It has been generally recognized that the acquisition of motor skills is a phenomenon related in a large degree to the specific task which is practiced. It would appear, however, that some of the theories applied to best learning may have roots in some fundamental considerations. Various studies (1,4,6, 8,9) investigating the relationship of kinesthesis to the acquisition of motor skills show little or no relationship. Others (7,11) show significant relationships in some aspects. Kerr and Weinland (3) concluded that "muscular perceptivity is a factor in skilled handwork." Young (12) employed a tennis ball throw at a target 12 feet distant and found very low correlation between scores in throwing and any of the measures of kinesthesis. Logan (5) and

Hellebrandt (2) have suggested that certain learnings may occur at a subcortical level involving feed-back and muscular adjustments of which the learner is kinesthetically unaware.

Purpose of the Study

Specifically, this investigation was conducted in order to (a) determine if there were differences in the nature in which skills were acquired while learning to use the nonpreferred hand in throwing a light object accurately and when learning to throw a heavier object accurately, and (b) determine the effects of transfer when a task for each group was reversed.

Apparatus and Procedure

On a covered concrete deck, free from wind, two identical experimental assemblies were constructed (Figure I). In each assembly there were three 2-inch lines painted on the deck. Line B was 5 feet beyond line A, which was the restraining line, and line C was 10 feet beyond line B. At each end of line B, standards 8 feet in height were erected. Each standard was calibrated in inches between 5 feet and 7 feet by affixing a measuring tape to each side. A crossbar 5 feet in length spanned the standards and was adjusted to a level 6 inches above each subject's standing heights. This placement necessitated an arched trajectory of the throw and prevented a direct forceful throw at the target. Line C fixed the nearest edge of the target which was constructed of ¼-inch steel formed into concentric circles. The center circle of the target had a diameter of 7 inches, the second circle had a diameter of 21 inches, and the outer circle had a 35-inch diameter. The target was inclined in a plane at an angle of 30 degrees with the deck and was fastened to the deck to prevent its movement.

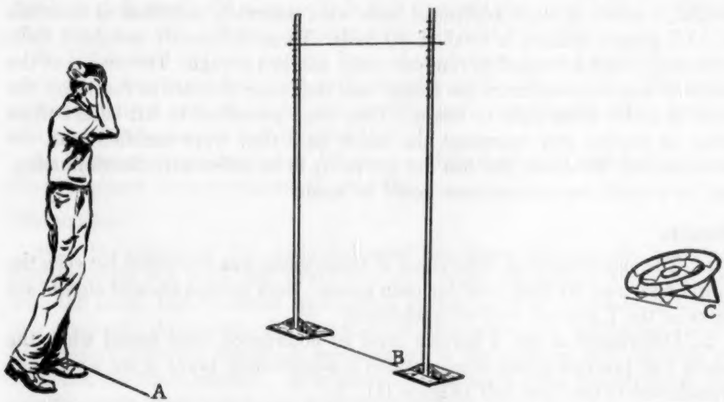

FIGURE I. Experimental Assembly.

The subjects, a coeducational group of 56 college students, were randomly divided into two groups which subsequently practiced overhand throwing for accuracy using the nonpreferred hand. The experimental variable was the differentiated weight of the balls used by each group—otherwise, the tasks for all subjects were identical. The subjects in group I, the light ball practice group, learned by throwing a light ball (2 oz.) while group II, the heavy ball practice group learned by throwing a heavier ball (6½ oz.). Both the light and the heavy balls used in the experiment were 12 inches in circumference. Both groups underwent an initial test of 50 trials after which each group then practiced during 10 daily sessions of 50 throws using the nonpreferred hand in which each throw was scored. At the conclusion of the practice trials the subjects in each group were tested in their ability to throw the opposite ball with the nonpreferred hand. At all times accuracy was emphasized and each attempt was scored. Values of 5, 3, and 1 were assigned to the three scoring areas of the target.

Combining the groups, a product-moment correlation of .67 was calculated for the reliability between the even and odd scores on the first 50 throws. In addition, a Spearman Rank Correlation Coefficient of .60 was calculated for the relationship between the even and odd scores of the initial test. The significance of the association between the even and odd scores exceeded the .001 level. Therefore, it appears that the initial test was highly reliable as a device for determining the initial level of skill of throwing a ball with the nonpreferred hand.

An attempt was made to determine the ability of the subjects to make rather fine discriminations in weight. It was intended that the ability to discriminate weight be related to the rate and degree of the acquisition of throwing skill. Using the heavy ball as the heaviest weight and the light ball as the lightest weight, a series of eight additional balls were internally weighted at intervals of 15.5 grams, making a total of 10 balls. These differently weighted balls were coded and arranged in random order inside a trough. The vision of the subjects was obscured from the trough and they were directed to rearrange the balls in order from light to heavy. They were permitted to lift each ball as often as needed and rearrange the order until they were satisfied with the arrangement. However, this test did not prove to be sufficiently discriminating, and as a result no comparisons could be made.

Results

1. The significance of differences in mean gains was computed between the initial trial and the final trial for each group. Both groups showed significant gains at the 1 percent level of confidence.
2. Differences at the 1 percent level of confidence were found when the heavy ball practice group demonstrated a significantly lower score when they transferred to the light ball (Figure II).
3. Differences at the 1 percent level of confidence were found when the final light ball scores were compared to the scores of the transfer to the light

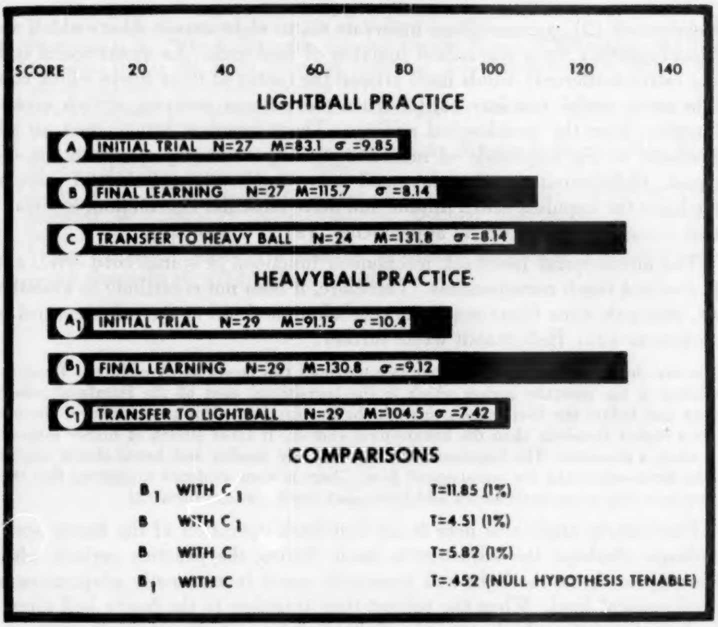

FIGURE II. Scoring and Comparison Relationships.

ball. The group which practices with the light ball performed significantly better in their final trial with the light ball than did the group which practiced with the heavy ball and then transferred to the light ball (Figure II).

4. Differences at the 1 percent level of confidence were found when comparing the final light ball trial with transfer to the heavy ball. The group which practiced with the light ball actually performed better when transfer was made to the heavier ball (Figure II).

5. There were no significant differences when the final heavy ball trials of the two groups were compared (Figure II).

Discussion

Since the results of this study indicated that those subjects who practiced with the light ball were able to transfer skill better than those who practiced with the heavy ball, it seems appropriate at this point to speculate as to why this occurred. Apparently the operation of neuromuscular facilitation involving sensory receptor feed-back mechanisms in the muscles and joints is responsible for these changes. It is plausible that some type of sharpened sensitivity results from practicing with the light ball.

Recent findings indicate that a large part of motor learning takes place at subcortical levels without involvement of the cerebral cortex. According to

Hellebrandt (2), gamma fibers innervate six to eight muscle fibers which are bound together for a specialized function of feed-back. An annulospiral ending (stretch-afferent) winds itself around the center of these fibers which contain many nuclei (nuclear bag). When these fibers contract, stretch evokes impulses from the annulospiral endings. These impulses bring about an adjustment in the amplitude of muscular activity commensurate with the demand. Hellebrandt stated: "the small nerve innervation of skeletal muscles mediates the impulses which initiate and drive muscular contraction, especially that concerned with postural adjustments" (2).

The annulospiral feed-back mechanism functions at spinal cord level, and it does not reach consciousness. Therefore, it does not contribute to kinesthesis, although some fibers reach the cerebellum and aid in the reflex control of movement (2). Hellebrandt wrote further:

> The muscle spindle also contains one or sometimes two flower spray endings. These are located in the myotube region which is the transitional area of the intrafusal muscle fiber just before the fibril passes through the nuclear bag. This proprioceptive receptor has a higher threshold than the annulospiral ending. It takes stretch of higher intensity to elicit a response. The impulses evoked travel over smaller and hence slower circuits than those subserving the annulospiral flow. There is some evidence suggesting that they pass on to the somesthetic cortex and hence may reach consciousness (2).

Particularly applicable here is the feed-back operation of the flower spray endings. Perhaps the adjustments made during the practice periods while learning to throw the light ball accurately result in automatic adaptations at a subcortical level. When the subject then transfers to the heavy ball after a period of practice, the increased weight elicits a response of the flower spray endings with their higher threshold which in turn brings the impulse to consciousness and thus aids in the reflex control of the throwing movement. Further, this would explain why subjects who learn to throw with the light ball performed better with the heavy ball on their first transfer trial than those who practiced with the heavy ball from the beginning.

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(Submitted 12/30/59)

Motor Performance of Girls Age 6 to 14 Years[1]

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Abstract

Group achievement scores for elementary school girls for the 30-yard run, the standing broad jump and the overarm throw are presented to add to the limited information now available on children in the first three grades (ages 6 through 9 years). Means and standard deviations are reported for grades 1 through 8 and for ages 6 through 14 years. Reliabilities of within-day scores are reported. Correlations of year-to-year scores and of first-grade scores with those of grades 3 through 5 show that individuals tend to remain in the same relative position within the group during the elementary school years. This paper adds to present knowledge of motor performance of elementary school children by reporting observations derived from achievement scores of girls during a five-year period.

OBSERVATIONS OF MOTOR performance of children in the early school years are limited. Many of the published reports of achievement in the elementary school begin with grade 4 or approximately age 10 years (1, 3, 4, 10, 12, 15). Records of performance for earlier years can be found in the following references. Of these six reports, one does not include ages below eight years; one reports jumping scores only; and one includes only balance records for boys.

Reference	*Ages Studied*	*Sex*	*Run*	*Jump*	*Throw*	*Balance*
Francis and Rarick (6)	8-14	B.G.	X	X	X	X
Holloway (7)	Grade 1	B.G.	X	X	X	
Jenkins (8)	5, 6, 7	B.G.	X	X	X	
Kane and Meredith (9)	7, 9, 11	B.G.		X		
Seashore (13)	5-18	B.				X
Seils (14)[2]	6-8	B. G	X	X	X	X

Study of motor performance in the early school years, and in preschool years, is needed not only for understanding children of these ages but for understanding motor development throughout the years of physical growth.

[1] Acknowledgment is given to the Wisconsin Alumni Research Foundation for financial support for this study; to the school officials, staff and community of Highlands-Mendota Beach School for their cooperation; and to the Board of Education and administrators of Madison, Wisconsin, Public Schools for approval of the study.

[2] Also reported agility, catching, and striking.

It is possible that the degree of coordination achieved throughout life depends upon that of preceding years.

Source of Data

In the school year 1953-54, three members of the University of Wisconsin faculty began a series of observations of elementary school children which included achievement scores in the run, overarm throw, and standing broad jump. The school in which the observations were made was selected for the following reasons: (a) the school population could be expected to be relatively stable (essential for longitudinal study) since 85 to 90 percent of the population owned their homes; (b) the location was convenient for frequent observations, within five miles of the university physical education offices; and (c) ample space was accessible for the children's free-time play, since none of the homes faced heavily traveled highways and many were adjacent to open fields and wooded areas. The last consideration was deemed especially important since the investigators were interested in the degree of coordination which can be achieved in the elementary school years without highly specialized instruction.

The school's physical education facilities were fair. The outdoor play space was ample; there was no gymnasium; a ground floor auditorium, one story in height, were available for indoor activity. For the first two years of the study, one half-time physical education instructor, a woman, was on the school staff; since the third year of observation, a second half-time teacher, a man, has shared the physical education instruction. Grades 1 through 4 had two 30-minute periods of physical education per week; the remaining grades, three 40-minute periods. The school had an excellent supply of balls, but no gymnasium or playground apparatus.

Subjects

The subjects whose scores are reported here are girls and are limited to those individuals (approximately 125) for whom there are performance scores for at least three consecutive years. To avoid confusion in identifying a given group, in 1953-54 the grades were named in alphabetical sequence. This designation was continued throughout the study. The number of subjects in each group and the grade level at the time the scores were taken are shown in Table 1.

Skills Measured

The scores which are reported are those which measure:

1. *Running Ability.* The score for each girl is the average of the times for two trials in a 30-yard run. The watch was started as the runner reached a line five yards from the starting line and stopped when she reached a line 35 yards from the starting line. This procedure was followed to eliminate reaction time and the time required to develop speed. It was considered a more valid measure of running ability than a time score in which the watch begins on the starting signal.

TABLE 1.—GROUPS BY NAME AND GRADE LEVEL WHEN MEASURES WERE TAKEN

Group	No. of Ss	Grade Level 1	2	3	4	5	6	7	8
Ken	22	X	X	X					
Jane	16	X	X	X	X	X	X		
Ivy	26	X	X	X	X	X			
Hank	18			X	X	X	X		
George	17				X	X	X	X	
Frank	13					X	X	X	X
Eager	11						X	X	X
	123	64	64	82	77	90	75	41	24

2. *Jumping Ability.* The jump was measured in inches and the individual score is the average distance of the two best jumps in four trials. The jumps were taken from a board two inches high and landings were on a mat one inch in thickness. Measuring procedures were standard.

3. *Throwing Ability.* The throwing performance was measured in feet per second; the score is the average of the velocities of the two best of four trials. A regulation hard baseball was used on the assumption that this size would be more easily grasped by the younger children. Velocity rather than distance of throw was scored because it is a more valid measure of the force developed by the throwing pattern. Distance is a function of velocity and angle of projection. In addition to the consideration of validity, the procedures for measuring velocity are more economical than are those of distance measures. A space 60 by 20 feet is sufficient; the time required for four throws is less than half that used to determine the distance measures. (For methods used to determine velocity see reference 11.)

Reliability of Measures

To determine the degree of within-day reliability of measures, the two scores used for each individual's record were correlated (Pearson Product Moment). These are presented in detail in Table 2 and are summarized as follows:

PERCENTAGE OF R'S WITHIN RANGES

	.95-.999	.90-.949	.85-.899	.70-.799
Run (24 r's)	62.5	16.6	12.5	8.3
Jump (26 r's)	76.9	15.3	7.6	----
Throw (20 r's)	40.0	30.0	20.0	10.0

Of the 70 coefficients presented here, only four are below .85. If the Spearman-Brown formula is applied to predict the reliability of the scores which were used in the data of this report, all predicted r's would be above .92, except the four now below .80, and all those now .90 or above would be above .95. These figures show remarkable consistency of scoring; it is reasonable to assume that the scores are a valid measure of performance for children for the day on which the measures were taken.

These r's are comparable to the .98 reported by Kane and Meredith for girls 7, 9, and 11 years of age for the standing broad jump and to the .90 for the run, .906 for the jump, and .980 for the throw reported by Seils.

One additional comment on the consistency of scores is of interest. At least two administrators were involved each year in collecting the data and, for the first three years, no individual served for more than one year. After that time, one administrator participated in the measuring program for three years, and she was assisted by a different individual each year. Correlation coefficients in Table 2, if read on the diagonal, show the r's obtained each year. The similarities between the r's of different years show that different administrators can obtain equally reliable scores.

Level of Performance

In compiling the records for presentation here, all grades of like levels have been combined. These then represent scores which have been collected over a period of years and the same children's measures will appear in more than one grade (see Table 1). The group measures for grades will be found in Table 3 showing a gain in mean score for each level. For comparison with age groups, the scores have been compiled by ages on Table 4, supporting the available evidence that performance scores improve with age.

Longitudinal observation makes possible a treatment of the scores to determine the degree to which a child maintains her position within the group. This was determined by correlations (Pearson Product Moment) of yearly scores and is presented in detail in Table 5. A summary of the correlations follows, showing the percentage of r's which fall within the indicated ranges.

	.90-.949	.85-.899	.80-.849	.75-.799	.70-.749	.65-699	Others
Run (19)	15.8	21.0	31.6	15.8	15.8	-----	-----
Jump (22)	9.1	9.1	36.4	13.2	13.2	18.2	-----
Throw (16)	6.3	18.8	18.8	12.5	6.3	-----	37.5

Within the seven groups of girls who were observed over a period of years, each individual tends to remain in the same relative position in her grade, especially in the run and jump. The evidence for the throw is less conclusive than for the run and jump.

Additional evidence of this tendency is shown when scores of the first grade are correlated with those of higher grades (see Table 6). These are shown for the Jane and Ivy groups only. The pupils in these groups have been observed for a more extensive study than is reported here.) Throw records for the longer period are incomplete.

Comparison with Available Records

Comparison of the jump records with other published records shows that these are higher than those previously reported, thus supporting the investigator's hypothesis that coordinations may be closer to possible development when children live in an environment which affords ample opportunity for free-time play.

TABLE 2.—CONSISTENCY OF WITHIN-DAY MEASURES[a]

	Run								Jump								Throw							
	Grade								Grade Level								Grade Level							
Group	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
Ken	97	96	86						97	87	89						86	87	91					
Jane	95		76	94					90	95	92	98							97	92				
Ivy	92	72	94	98					95	95	98	98						78	96	86	98			
Hank				96	95	99					98	97	94	95						93	94	99		
George				96	88	97	95					98	97	94	95						92	72	98	
Frank					87	95	97	97					96	99	98	96						97	93	99
Eager						93	95	98						97	99	98							96	86

[a] Decimal points are omitted in the table.

TABLE 3.—MEANS AND STANDARD DEVIATIONS OF PERFORMANCE SCORES OF GIRLS IN GRADES 1-8

	Run (in seconds)			Jump (in inches)			Throw (in feet per second)			
Grade	No.	Mean	SD	No.	Mean	SD	No.	Mean	SD	Distance[a]
1	52	6.18	.652	59	41.67	5.90	22	28.3	5.2	28.1
2	42	5.63	.472	64	46.31	5.85	48	33.7	5.1	38.5
3	58	5.32	.372	82	50.7	5.21	72	34.5	5.4	40.2
4	72	5.07	.409	72	56.55	7.13	69	38.7	5.9	49.9
5	71	4.89	.417	74	59.91	6.51	61	41.9	6.4	58.0
6	67	4.74	.472	64	63.40	6.40	50	47.2	8.1	73.0
7	46	4.47	.443	47	65.00	6.87	47	50.1	7.5	81.9
8	45	4.28	.396	46	68.3	6.63	31	54.3	10.6	95.6

[a] Estimated if projected at 40 degrees above horizontal.

TABLE 4.—MEANS AND STANDARD DEVIATIONS OF PERFORMANCE SCORES OF GIRLS AT AGES 6-14 YEARS

Age	Run—30 yd. (in seconds)			Jump (in inches)			Throw (in feet per second)		
	No.	Mean	S.D.	No.	Mean	S.D.	No.	Mean	S.D.
6	26	6.37	.70	26	40.5	7.1	22	29.1	7.3
7	49	5.85	.58	59	43.5	6.6	41	30.5	6.2
8	54	5.56	.50	67	47.7	5.8	63	34.7	6.5
9	64	5.24	.41	81	52.9	7.6	68	36.4	6.9
10	80	5.02	.44	77	57.6	7.4	65	40.7	7.1
11	73	4.79	.61	73	61.5	7.4	63	44.0	8.3
12	42	4.60	.42	47	63.9	6.0	36	48.6	7.6
13	24	4.42	.48	22	68.0	6.2	25	51.9	10.3
14	12	4.25	.5	12	69.7	6.2	13	58.7	11.9

[a] Each age represents a 12-month span beginning with 67-78 months.

TABLE 5.—YEAR TO YEAR RELATIONSHIPS IN PERFORMANCE SCORES (DECIMAL POINTS OMITTED)

Group	Run Grade Level								Jump Grade Level								Throw Grade Level							
	No.	1-2	2-3	3-4	4-5	5-6	6-7	7-8	No.	1-2	2-3	3-4	4-5	5-6	6-7	7-8	No.	1-2	2-3	3-4	4-5	5-6	6-7	7-8
Ken	21	716	812	787					22	746	772						22	642	777					
Jane	16			900	773[a]	800			16	673	739	763	808[a]				16			900	773[a]			
Ivy	21	712	748	802	876[a]	843[a]			26	651	823	849	828[c]	832[c]			26	468	732	623	876[b]	843[b]		
Hank	20				910	900			18			833	902	669			19				866	813		
George	17				846		816		17				901	776	826		16					526	466	
Frank	13						767	827	13					811	874	864	15						888	808
Eager	12						852	885	11						731	677	16							568

[a] 26 scores.
[b] 31 scores.
[c] 32 scores.

JUMP RECORDS (IN INCHES)

(*Means followed by standard deviations*)

Grades	1	2	3	4
Holloway	40 5.3			
Seils	35.6 5.5	35.2 6.5	41.9 6.9	
This Study	41.7 5.9	46.3 5.8	50.7 5.2	56.5 7.1

Ages	6	7	8	9	10	11
California				49	52	55
Jenkins	38, 7.8	41, 7.7				
Kane and Meredith		39.9		47.7		53.4
Youth Fitness					51	54
This Study	40.5, 7.1	43.5, 6.6	47.7, 5.8	52.9, 7.6	57.6, 7.4	61.5, 7.4

No comparison of running or throwing data is presented here because administrative procedures differ. Jenkins measured a 35-yard dash; Holloway, 30 yards, and Seils, 40 yards. Throwing scores are reported in distance and various types of balls are used (soccer, tennis, and an indoor baseball); in this study, a regulation hard ball was used and the score is expressed in feet per second.

Correlations between year-to-year scores and between scores for longer periods of time have not been previously reported. However, the high degree of relationship reported here agrees with the findings of Espenschade (5) in studying motor performance of adolescent girls.

Discussion

This report suggests directions for further investigation of motor development. It adds to the already well-established evidence that during childhood, motor performance scores improve. Further study should attempt to determine the factors underlying this improvement, such as greater segmental lengths, improved patterns of coordination, and greater strength relative to body size. This report shows that previously published norms are lower than those which can be achieved and suggests that the physical educator should strive for higher group goals than are now available in published literature.

The indication that girls tends to maintain the same relative position within the group suggests at least two possible explanations. It may be that early

TABLE 6.—CORRELATIONS OF FIRST GRADE SCORES WITH HIGHER GRADE SCORES

	Run			
Grades	1-2	1-4	1-5	1-6
Jane	.622	.676	.817	
Ivy	.746	.813	.871	.702
	Jump			
Jane	.749	.651	.663	
Ivy	.594	.698	.560	.739

development of motor coordination is essential for later success or that an inherent native motor ability may determine the limit of achievement during the growing years.

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Personality Traits and Teaching Attitudes

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Abstract

This study was concerned with determining whether or not undergraduate male students majoring in physical education at Purdue University project the same personality traits and attitudes toward teaching as do successful male teachers of physical education who received their undergraduate training at Purdue. The instruments used to measure personality and attitudes were the Guilford-Zimmerman Temperament Survey and the Minnesota Teacher Attitude Inventory. Significant differences between the means were not obtained when comparing personality and attitude mean scores as projected by students and teachers. However, an item analysis revealed that many items were hidden behind personality and attitude mean scores which would significantly discriminate between teachers and students.

IT IS AXIOMATIC that the outcomes of health education, physical education, and recreation, like other areas of education, depend largely upon the nature and quality of the leadership provided. Hence, it is mandatory that we have some basis on which we select and train teachers of physical education. This study has been concerned with two variables in the selection and guidance of prospective teachers of physical education at Purdue University. These two variables are personality characteristics of teachers and attitudes toward teaching. According to many investigators, these two variables, along with intelligence, health, motor ability, and interest, are of prime importance for the successful teaching of physical education (1, 2, 6, 7, 8, 9, 10).

The general purpose of this study was to compare successful male teachers of physical education with undergraduate male students majoring in physical education on selected instruments designed to measure personality traits and attitudes toward teaching. It was hoped to acquire more information about two instruments which may be of use when selecting students for professional training in physical education by investigating the tenability of the following hypotheses:

1. Significant differences do not exist in mean scores obtained on the personality and attitude inventories between students in training (N = 203) and all teachers (N = 112).

2. Significant differences do not exist in mean scores obtained on the personality and attitude inventories between most successful teachers (N = 35) and least successful teachers (N = 35).

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[1]This report is taken from the findings of a study conducted under the direction of Lee E. Isaacson, associate professor of education at Purdue University, in partial fulfillment of the requirements for the Doctor of Philosophy Degree in Education at Purdue University.

3. Significant differences do not exist in mean scores obtained on the personality and attitude inventories between most successful teachers (N = 35) and students (N = 203).

4. Significant differences do not exist in mean scores obtained on the personality and attitude inventories between least successful teachers (N = 35) and students (N = 203).

5. No significant differences exist in the proportions of responses to items obtained on the personality and attitude inventories between the various teacher and student combinations.

Procedures

Description of Instruments. The Guilford-Zimmerman Temperament Survey, hereafter referred to as the GZTS, and the Minnesota Teacher Attitude Inventory, hereafter referred to as the MTAI, were selected to measure personality and teacher attitudes in this investigation because both seem to possess sufficient validity and reliability to evaluate attitudes and personality traits well enough to be of importance in general selection schemes (3, 5).

The GZTS, composed of 300 items, puts into one schedule 10 personality traits (30 items per trait) which have been isolated by Guilford through factor analysis techniques. As a consequence of validation information (5), the following brief interpretations of the traits are offered:

General Activity (G). A high score indicates strong drive, energy, and activity. Low scores suggest relative slowness and inactivity.

Restraint (R). Low scores suggest that an individual is happy-go-lucky, carefree, and impulsive. High scores indicate an over-restrained, and over-serious individual.

Ascendance (A). High scores suggest social boldness; low scores suggest submissiveness.

Sociability (S). The high and low scores indicate the contrast between the person who is at ease with others, enjoys their company and readily establishes immediate rapport, versus the withdrawn, reserved person who is hard to get to know.

Emotional Stability (E). A high score indicates optimism and cheerfulness, whereas low scores suggest depressive tendencies.

Objectivity (O). High scores mean less egoism; low scores mean touchiness or hypersensitivity.

Friendliness (F). A high score may mean an urge to please others, and a desire to be liked. A low score means hostility in one form or another.

Thoughtfulness (T). High scores suggest introversion and self-centeredness. Low scores suggest extroversion.

Personal Relations (P). A high score should mean tolerance and understanding of other people and their human weaknesses. A low score indicates fault finding and criticalness of other people and of institutions in general.

Masculinity (M). On the positive side, a high raw score in this area means that the person behaves in ways characteristic of men. If the "M" score is very high, it may mean that the person is somewhat unsympathetic and callous.

According to the test manual (3), the MTAI, composed of 150 items, is designed to measure those attitudes of a teacher which predict how well he will get along with pupils in interpersonal relationships, and indirectly how well satisfied he will be with teaching as a vocation. Items in the MTAI discriminate sharply between teachers who have and those who do not have

good rapport with pupils; examination of these items indicates that inferior teachers are essentially insecure socially.

Sampling Procedures. These inventories were administered to a group of 203 undergraduate male majors of physical education at Purdue University while enrolled in the first course in the professional education sequence (usually taken the second semester of the sophomore year). The inventories were also administered to a group of 112 physical education teachers who graduated from Purdue. These teachers were invited to participate in the study by a letter sent to all graduates of the 1947 to 1958 classes inclusive with known addresses. Of the teachers contacted, 112 not only agreed to participate, but they returned completed, usable answer sheets.

The subjects involved in this investigation were not drawn at random. They were selected according to the following criteria: (a) availability of data and (b) willingness to participate in this study. These criteria were employed in lieu of random sampling in order to have samples of sufficient size to secure better reliability.

The teaching group was further subdivided into a most successful teaching group, a successful teaching group, and a least successful teaching group on the basis of experts' rating on this 3 point scale. The three experts consisted of the head of the graduate curriculum in physical education, the head of the undergraduate curriculum in physical education, and the supervisor of student teachers in physical education. All three experts had the teachers as students during their stay on campus and have had varying contacts with them as alumni. The following directions were given to the raters.

> Rate 35 teachers as most successful and 35 teachers as least successful. Place into a successful group (N = 42) the remaining teachers whose degree of success is uncertain. The following criteria were employed for rating purposes. First, examine each personnel record card[2] carefully and look for information which would indicate success in a teaching and coaching situation such as: (a) continued employment in any one school; (b) advancement from small school to large school; (c) educational improvement; (d) advancement from assistant to head coach; (e) responsibilities of job now held; (f) present salary; (g) any professional advancement in Health, Physical Education, Recreation, school administration; boys club work, Y.M.C.A. and other social agencies; and (h) university administration and teaching. Second, couple this information with your personal knowledge of the teacher's ability.

One year later these same experts rerated the teachers.[3]

Statistical Procedures. Hypotheses one through four were tested at the .05 level of significance by employing the appropriate t test (4) for the difference between means of the various traits of the GZTS and the MTAI. Eleven t tests were run for each hypothesis in order to compute a t_G, t_R, t_A, t_S, t_E, t_O, t_F, t_T, t_P, t_M, t_{MTAI}.

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[2]The departmental record cards give a rather accurate picture of alumni progress since graduation as the alumni are followed up every three years.

[3]A Pearson product-moment correlation of .840 was obtained which is significant beyond the .01 level of confidence, thus indicating high reliability of rating. (Average rates objectivity was .557.)

Hypothesis five was tested by conducting an item analysis of the types of responses projected on the instruments by the various groups concerned. The $\bar{z}$ statistic (4) was employed to test for the differences between uncorrelated proportions. Items on the MTAI can be answered in any one of five different categories, namely: strongly agree, agree, undecided, disagree, and strongly disagree. For the purpose of simplifying computations these five categories were reduced to two, namely: agree, which is actually composed of the strongly agree and agree responses, and to disagree, which is composed of the disagree and strongly disagree responses.

Items on the GZTS can be answered in any one of three different categories, namely; yes, ?, and no. These were converted to agree and disagree for uniformity of interpretation. The question mark and undecided responses were omitted since they are neutral. Hence, the $\bar{z}$ test employed concerns testing for the differences between the proportions of the various samples responding either agree or disagree to the inventory items. Since 450 items were compared on the basis of two types of responses, there are 900 responses in all. Subsequently, there were three student teacher comparisons made on each response; therefore, 2700 $\bar{z}$ statistics were tested for significance at the .05 level of confidence.

Results

The data presented in Table 1 indicate that the mean scores of the 10 traits of the GZTS and the MTAI do not significantly distinguish between the teacher and student groups. The teachers do have a slightly higher mean score on traits R, E, O, and P—but not significantly so.

The mean scores are also essentially the same for all 10 traits of the GZTS and the MTAI when most successful teachers and least successful teachers are compared. The most successful teachers and students also projected essen-

TABLE 1.—MEAN SCORES FOR ALL TEACHERS, STUDENTS, MOST SUCCESSFUL TEACHERS AND LEAST SUCCESSFUL TEACHERS ON THE GZTS AND THE MTAI

Trait	Student Mean Score (N = 203)	Teacher Mean Scores (N = 112)	Most Successful Teacher Mean Score (N = 35)	Least Successful Teacher Mean Score (N = 35)
G	17.18	18.38	19.14	18.49
R	14.75	17.63	18.34	17.09
A	16.74	16.23	17.31	15.71
S	20.84	20.37	20.29	20.49
E	16.90	19.90	20.51	19.17
O	16.92	18.98	17.97	19.23
F	13.75	15.46	15.91	14.20
T	17.31	18.69	19.11	18.34
P	17.12	19.88	19.83	19.26
M	19.27	19.64	19.80	19.80
MTAI	154.47	157.67	156.03	156.11

tially the same mean scores on the ten traits of the GZTS and the MTAI with the teachers scoring slightly higher in traits R and E.

These two instruments do not significantly differentiate between the mean scores of the least successful teachers and the student group. Not one t value approached significance at the .05 level of confidence for any of the traits under the various combinations mentioned above.[4]

On the basis of the data presented in Table 1 and within the limitations of sampling procedures, the results obtained from the various student-teacher comparisons indicate that the first four hypotheses are tenable. Thus the samples studied are from the same population in reference to the measured attitudes and personality traits.

Whenever statistical tests concerning means reveal that significant differences do not exist, and whenever logic concerning the research design indicates that differences should exist, it is extremely important to conduct an item analysis in order to show that there are really no hidden differences. The item analysis of the GZTS reveals that responses to 27 items significantly discriminated between most successful and least successful teachers. The GZTS had a total of 88 items which significantly discriminated between most successful teachers and students. The GZTS also had a total of 71 items which significantly discriminated between least successful teachers and students.[5] Item significance was established at the .05 level of confidence.

Comparison of the results of the item analysis on the MTAI shows that 14 items significantly discriminate between most successful and least successful teachers. A total of 52 items also significantly discriminated between most successful teachers and students. The MTAI also possesses 47 items which significantly discriminated between least successful teachers and students.

These results indicate that hypothesis 5 is tenable for many items; i.e., many items will not discriminate between teachers and students. It is also evident that many items did significantly discriminate between teachers and students at the .05 level of confidence. Thus we may conclude that the teachers and students are not from the same population in terms of these significant items which served as the criterion measure.

Discussion and Conclusions

On the basis of the obtained results, it may be concluded that the GZTS and the MTAI are two instruments which do not discriminate between successful teachers and students as indicated by their projected mean scores. Thus, it appears that these instruments would be appropriate instruments to include in a selection and guidance program for potential students of physi-

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[4] Values for the standard error of the difference between means and t values for the various comparisons are not included in Table 1 in an effort to conserve space. They are available from the author upon request.

[5] The author has copies of the significant items for each hypothesis tested available upon request. Examples of significant items are not included in this report since the items themselves are meaningless unless the individual is thoroughly familiar with the nature of the inventories used.

cal education, since students are projecting the same traits as are the teaching groups. These results seem somewhat contradictory to previous studies, namely, that mean scores do change with training and experience. Training and experience, however, do not seem to influence the mean scores of the samples employed in this study.

It could well be possible that changes in traits do occur but are hidden in the test items themselves. On the basis of the results of the item analysis this suspicion was confirmed since large numbers of items did discriminate significantly between students and teachers. Evidently, degree of success, training, experience, and level of employment, i.e., elementary, secondary, college, community, or industrial recreation, could account for these significant differences in item responses. All of these significant items indicate that sometime after testing as a college sophomore, and before the time of testing as a successful teacher, something happens to the individual which changes the type of response projected to test items on the MTAI and the GZTS, assuming that the two groups are homogeneous.

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(Submitted 11/23/59)

Factorial Structure of Speed and Static Strength in a Lateral Arm Movement[1]

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Abstract

Speed of movement in a lateral adductive arm swing was timed at seven equidistant points on an arc of 120 degrees. Static strength and effective arm mass were measured in the movement position. Data obtained on 36 men and 36 women were subjected to a centroid factor analysis. The structure for both sexes consisted of a single common factor for arm speed and a substantial item-specific factor for the first 17 cm. of movement, suggesting that the velocity curve probably consisted of two components. The correlations between the strength/mass ratios and speeds of movement were almost zero, except in the middle phase of the action, where the relationship was .29 for men and .27 for women (.36 and .34 when corrected for attenuation). These very low correlations supported the hypothesis of neuromotor specificity. Circumferential speed for women was 17 percent slower than for men, partly because their arms were shorter. In angular speed, the sex difference was only 5 percent.

IN A PREVIOUS article (2), it was shown that principles of physics required that in a simple lateral arm movement, the ratio of the muscular strength (measured with the arm in the movement position) to the effective mass of the moving arm (as pivoted at the shoulder) must be accepted as the logical index of strength that would a priori be expected to determine the maximal speed of the movement. It was argued, however, that the measured static strength is not necessarily equal to the effective force exerted during a movement. An hypothesis was advanced to the effect that the static strength of a muscle group is controlled by a neuromotor coordination pattern that is probably different from the neuromotor pattern for exerting strength by that muscle group during a movement, therefore the correlation between individual ability to exert static strength and ability to make a fast movement should be low. This would be consistent with accumulating evidence for extremely high specificity in neuromotor coordination abilities (2). The data confirmed the expectations of the hypothesis; the observed correlations between speed and the strength/mass ratio were very low in each of two groups of male subjects who were timed in a lateral arm swing of approximately 90 degrees at maximal speed.

Analysis of the data revealed internal evidence suggesting that the movement might have a large ballistic component. There seems to be a possibility,

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[1] From the Research Laboratory of the Department of Physical Education, University of California, Berkeley. The experiment described in this report was supported by a grant from the Faculty Research Fund. The writer is indebted to Dollie C. Carston for technical assistance in securing the data.

therefore, that a higher correlation might be found between the strength/mass ratio (s/m) and the speed of motion (d/t) in the earlier parts of the movement, or perhaps even at other parts of its range. It was decided to repeat the experiment with new samplings of subjects, timing the motion at a series of stations spaced about 15 degrees apart, and extending some distance beyond the original 90 degrees. It was thought that comparative data on men and women would be of general interest. The present report examines the results of such an experiment. It is limited to an analysis of the individual differences aspect of the problem, treated generally rather than with reference to the form of the velocity and acceleration curves or the absolute values of the forces, speeds, and masses involved in the movement. These latter considerations require a different type of analysis, which will be presented in a later report.

Apparatus and Method

Movement. The subject stood erect, with his shoulders touching a wall. The side of the hand of his laterally extended right arm rested on the first microswitch. Keeping his elbow and wrist rigid and avoiding body twist, he swung him arm leftward past the medial plane of the body, moving as fast as possible to strike consecutively each of a series of timing strings (Figure I). In this movement, the arm described a horizontal arc of approximately 120 degrees.

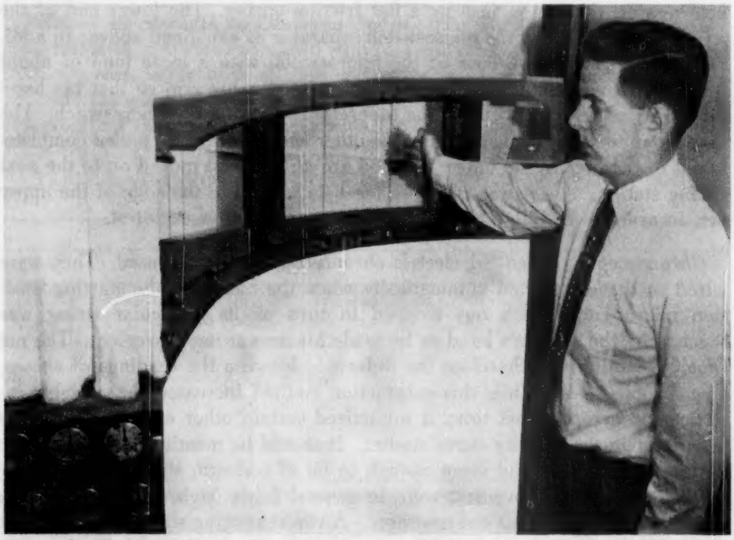

FIGURE I. The Seven-Station Timing Apparatus. The subject's hand has left the first microswitch (which can be seen just above his elbow) and has passed through the first timing string.

Timing Stations. These were placed at 15 degree intervals on a radius of 66 cm. from the subject's right shoulder joint. (This turned out to be 16.8 degrees of movement for the average subject of the present experiment since the mean arm length was 59 cm.) A timing station consisted of a roller type microswitch, with its contact held closed by a separator (a small plastic rectangle slipped between the roller and a fixed bracket, and fastened to the timing string). Touching the string pulled out the separator, thus operating the microswitch and stopping the chronoscope that it controlled. Seven such stations (in addition to the first microswitch at the starting position) were regularly spaced at intervals of 17,27 cm. close to the inner circumference of a horizontal plywood arc 25 cm. wide. This was hinged to the wall at the starting end of the assembly at a height of 122 cm., and was supported by legs at its middle and terminal end. It was possible to swing this assembly closer or farther from the wall in order to accommodate subjects of different arm lengths. There was also provision for adjusting the distance from the floor to accommodate subjects of widely different heights. The terminal target (a free-hanging towel) was placed 17 cm. beyond the last timing station.

A second plywood arc was mounted 30 cm. above the first by means of spacers on its periphery. A hole was drilled above each timing station microswitch, so that the string attached to each plastic separator could be passed vertically upward through the top plywood arc, where it was bent over and held against the top surface by a flat friction spring. The lower end of the string was attached to the microswitch separator as explained above; in addition, it was tied to the base of the microswitch with a loose loop of about 5 cm. Summarizing the action, the subject swung his arm so that his hand hit the string. This pulled out the separator, operating the microswitch. The lower loop then came tight, so that the other end of the string pulled completely out of the hole in the upper plywood arc as the hand moved on to the next timing station. A slot was cut from the hole inward to the edge of the upper arc, in order to facilitate restringing the apparatus after each test.

Chronoscopes. Seven S-1 electric chronoscopes (2) were used. They were wired so that all started automatically when the hand left the starting position microswitch; each one stopped in turn as its particular string was touched by the subject's hand as he made his arm swing movement. The net time per station was therefore the difference between the readings of successive chronoscopes. While this subtraction method increased the variable instrumental error for net time, it minimized certain other errors that will be important in the velocity curve studies. It should be mentioned here that the variable errors were not large enough to be of concern, since the reliability coefficients for net movement were in general fairly high, as will be shown later. Reaction time was not measured. A visual starting signal was used, but each subject was informed that he should not start until he felt ready, after the signal flashed.

Subjects and Trials. Thirty-six men and an equal number of women were tested. These subjects were predominantly undergraduate physical education majors. The mean age of each group was 21.1 yrs.; the age variability was the same in each ($\sigma = 2.6$). A subject was given five or more preliminary trials, the exact number being determined by the experimenter's judgment. The criterion was full understanding of the technique and sufficient practice to reach an apparent plateau in performance. Twenty official trials were then made, each separated by a rest period occupied by the subject helping the experimenter reset the timing stations. The time required for this phase of the experiment was usually about 45 min.

Strength and Arm Mass. These measures were made immediately after the speed test, using the techniques described in detail in the previous study (2). The subject reclined on his back; the dynamometer (a spring balance) was pulled by a strap at the reference point on the subject's hand (the knuckles), the position being comparable to that used in the arm speed test, with the arm extended and rigid. The effective arm mass was determined by weighing the arm at that reference point, considering it as a level pivoted at the shoulder. Relaxation was ensured by permitting the arm to rest on a plywood strip under it, that extended from the hand to a hinge under the shoulder joint. Two strength measurements and five mass determinations were made.

Results and Discussion

Relation of Strength to Observed Speed. The mean individual strength/mass ratios (s/m) were correlated with individual mean speeds as determined from the cumulative time at each successive measurement station. The coefficients are given in Row 9 of Table 1. They are very low. It should be observed that the reliability coefficients for the speeds, computed by the odd-

TABLE 1.—INTERCORRELATIONS FOR SPEEDS OF MOVEMENT AND THE STRENGTH/MASS RATIO

	Men							Women						
Item[a]	2	3	4	5	6	7	8	2	3	4	5	6	7	8
1	.05	−.15	.05	.10	.12	.17	−.13	.53	.48	.47	.41	.38	.21	.11
2		.57	.53	.70	.78	.65	.09		.57	.57	.44	.90	.08	.10
3			.40	.59	.64	.57	.29			.60	.63	.70	.48	.15
4				.74	.66	.66	.15				.32	.72	.44	.27
5					.85	.80	.02					.65	.54	.19
6						.61	.14						.65	.16
7							.08							.04
9[b]	−.09	−.02	.01	.04	.07	.08	−.13	.11	.09	.15	.16	.19	.16	.11
r^{c}_{11}	.96	.96	.97	.97	.98	.96	.97	.97	.97	.98	.98	.98	.98	.97

[a] The first seven items are the net speeds between the successive timing stations; Item #8 is the s/m ratio.

[b] The row of coefficients designated #9 are correlations between the s/m ratio and the speed computed from the cumulated time at each station; these correlations were not used in the factor analysis. Note that the correlation for the first timing station is tabled under Column #8.

[c] These are reliabilities for the cumulated time at each station. The reliabilities for the net speeds between each station, some of which run considerably smaller, are given in Table 2.

even split half technique and then converted to the full test length, range from .96 to .98 (Table 1). The reliabilities of the s/m ratios (computed by the same method) are also high, being .97 for both men and women subjects. There is, therefore, *neuromotor specificity* as between "strength in action" (speed) and static strength using the same muscles (2).

Correlations between the s/m ratios and the net speeds of movement between stations were also computed. They are shown in Column #8 of Table 1. Here, there is a suggestion in both groups of a correlation tendency in the middle part of the arm swing, the highest value being .29 for men and .27 for women. It should be noted that the coefficient would have to exceed .32 to differ significantly from zero at the 5 percent level with 36 subjects. When corrected for attenuation in both variables (using the reliability coefficients given in Table 2), the highest correlation is .36 for the men and .34 for the women. Technically, therefore, the corrected coefficients are both significant, although one should have some reservation about this since the highest of a series has been selected in each case. An argument in favor of accepting the relationships as significant is that they occur at a similiar phase of the arm swing in both groups; the critical value for a sample of 72 cases would be $r = .23$).

Factor Analysis. In view of the relatively low intercorrelation between some of the items shown on the diagonal in Table 1, more than one factor might be involved in the structuring of individual differences in speed in the different parts of the arm swing. The s/m ratio might be related to one of the factors. A factor analysis of the matrix of intercorrelations for each of the groups has accordingly been made, using the centroid method with successive approximations to stabilize the communalities. The analysis has been carried to three factor extractions. The critical size of the Tucker test ratio for terminating factor extractions (1) is 0.88 for an eight item analysis. The observed ratio for the men is 0.38 for Factor II vs I, and 1.00 for III vs II; for the women, the corresponding ratios are 0.42 and 0.93. Extraction of the third factor is therefore not justified.[2]

The unrotated factor loadings, as well as the communalities and reliabilities, are given in Table 2. While the analysis is interpretable as it stands, it may be noted that a few degrees of counter-clockwise rotation of the axes (Table 3) reduces the already low loadings in Factor II to the point that statistical significance at even the liberal 5 percent level is highly questionable for any of the items in the rotated second factor B′. In other words, there is only one factor, namely Factor I (or Factor A′ after rotation). The loadings are in general quite high in this "speed of arm movement" factor for all items except #1 (the first 15 degrees of movement) and #8 (the s/m ratio). The factorial structure is essentially of the classical Spearman type (1), consisting

[2] Use of the Tucker test is evidently misunderstood by some workers in our field. The criteria are increase in ratio size beyond the critical value, and a deceleration of the change in ratio size after the last true factor has been extracted. The ratio can subsequently drop and rise again with continued extraction of unjustified factors (1).

of a single common factor and specific factors unique to each item, as will be discussed later.

It makes an interesting exercise in mathematics to rotate the factorial axes so as to maximize the second factor loadings for the s/m ratio. This has been done in Table 3 (Factor B″). Observe that the loading for #8 is still not significantly different from zero in the men; it remains so small as to be of dubious significance in the women. If the results in the two groups were averaged, the factor loading for s/m would be almost exactly zero, since the vector directions are nearly opposite. Careful study of the factor graphs fails to yield any indication that other rotations would be meaningful. Moreover, it must not be forgotten that the correlations between the s/m ratio and speeds based on the cumulated time per successive station are very close to zero, even though the reliabilities are very high (Table 1).

It should be noted that the dynamic strength involved in the movement could not be treated as an item distinct from speed in the factor analysis, because this type of strength (in proportion to arm mass) is speed by physical definition (2).

TABLE 2.—RELIABILITY COEFFICIENTS AND UNROTATED FACTOR LOADINGS FOR NET SPEED BETWEEN STATIONS[a]

	Men					Women				
Item	I	II	h^2	r_{11}	b^b	I	II	h^2	r_{11}	b^b
1	.06	.28	.08	.97	.94	.57	.28	.40	.97	.75
2	.80	−.12	.66	.89	.48	.76	−.08	.58	.84	.52
3	.68	−.38	.61	.62	.13	.80	.15	.66	.77	.33
4	.74	.16	.58	.75	.42	.74	−.02	.55	.66	.33
5	.92	.17	.87	.88	.11	.70	−.06	.49	.73	.49
6	.91	−.13	.85	.96	.34	.89	−.42	.97	.97	.00
7	.85	.28	.79	.90	.33	.60	−.16	.38	.95	.75
8[c]	.15	−.28	.10	.97	.93	.21	.29	.13	.97	.92

[a] Four significant figures were used in computing the correlation matrix and factor analyses.
[b] Item-specificity was computed in the usual manner, namely $b = \sqrt{r_{11} - h^2}$ (1).
[c] Item 8 is the s/m ratio.

TABLE 3.—ROTATED FACTOR LOADINGS (ORTHOGONAL)

	Men (−4°)[a]		Women (−6°)[a]		Men (28°)[b]		Women (−37°)[b]	
Item	A′	B′	A′	B′	A″	B″	A″	B″
1	.04	.29	.54	.33	.19	.22	.28	.57
2	.81	−.07	.77	.00	.65	−.49	.65	.40
3	.70	−.33	.78	.23	.42	−.66	.54	.61
4	.75	.21	.74	.05	.73	−.21	.60	.44
5	.90	.22	.70	.01	.89	−.28	.58	.38
6	.92	−.07	.93	−.32	.74	−.55	.96	.22
7	.83	.33	.61	−.09	.88	−.15	.57	.25
8[c]	.17	−.27	.18	.32	.00	−.32	−.01	.36

[a] Rotated to minimize loadings in Factor B′. A loading of .33 is required for statistical significance at the 5 percent level.
[b] Rotated to maximize loadings of Item 8 in Factor B″.
[c] Item 8 is the s/m ratio.

Item Specificity. Factor analyses in our field neglect uniqueness, or in particular that part of the uniqueness that is called specificity (1). Examination of typical analyses reveals that the specificity is often greater in magnitude than the factor loadings, and should be considered just as important as the other outcomes of an analyses if we hope to really understand the structure of individual differences in motor ability. Table 2 shows that the loading for item-specificity b is very high for the s/m ratio; the evidence is clear that individual differences in this item are chiefly unique to it and are thus unrelated to speed of movement. No rotation of factor axes could alter this finding.

The large loading for item-specificity in Item #1 is also revealing. Evidently there are large individual differences in speed in the first 27 cm. of movement that are unrelated to speed in the other parts of the arm swing. This characteristic is exceptionally powerful in the men ($b = .94$), although it is definitely present in the women also ($b = .75$). It should be mentioned again that the magnitude of the item-specificity coefficient b is independent of rotation of factor axes, or of algebraic sign of loadings. The high specificity component of Item #1 suggests that the velocity curve of the arm movement may consist of two components.

There is also a rather large amount of item-specificity for the last 17 cm. of movement in the case of the women. This is not unexpected. The average effective arm length for the men is 62.1 cm. ($\sigma = 3.81$); for the women it is 56.0 cm. ($\sigma = 2.82$). Since the distance between each station is 17.27 cm., the average angular movement for the men at Station #7 is 111.5 degrees, compared with 123.7 degrees for the women. The women move the same circumferential distance as the men, namely a total of 120.9 cm., but their angular movement is 12.2 degrees further. The range of normal angular rotation in this type of movement was not known before the experiment. Evidently, 111.5 degrees does not exceed this amount, insofar as one can trust the factor analysis of the male data on this point; the item specificity b for #7 seems to be average rather than unusually high (Table 2). The data of the women, however, show that this item has a specificity loading of .75, which is definitely high. It is believed that this is the result of the angular distance at #7 being beyond the range of normal standard movement for many of the women, causing shoulder twisting or other complications. It may be noted that for women whose arms are 1 σ below average arm length, the angular movement would be 130 degrees, which is indeed rather large. In contrast, the men who are 1 σ below average are moving 118 degrees, which is the same angular movement as made by women who are 1 σ above average arm length; in other words, only the relatively long-armed women are within the main part of the men's distribution.

Sex Differences. As explained earlier, analysis of the velocity curves and similar aspects of the study will be presented in a later article. The data have, however, been examined for sex differences in speed at Station #6 (nominal

90 degrees), which has required 103.6 cm. of movement of the reference point on the hand. The average speed for men for this distance is 676 cm./sec. The women move 17 percent slower, i.e. 78 cm./sec.; the t-ratio for the difference is 6.18, which is unquestionably significant. Compared as to angular speed, which in effect equates the sexes with respect to differences in arm length, the slowing is only 5 percent; the men move at 624 degrees/sec. compared with 592 for the women, and the t-ratio, 2.22, is barely significant at the 5 percent level. The interrelationships of individual differences, as discussed earlier, do differ somewhat in details when the sexes are compared, but there is a remarkable similarity in their factorial structures as exhibited in the tables.

Summary and Conclusions

The speed of a 120 degree lateral arm swing was measured at seven consecutive timing stations spaced at intervals of approximately 17 degrees. Measurements of arm strength and effective mass were also secured. Thirty-six college men and 36 college women were tested. The reliability of individual differences in all measures was relatively high. The data were correlated and subjected to a factor analysis, leading to the following conclusions:

1. The factorial structure of the fractionated arm movement speed is predominantly of a highly saturated single common factor nature, and is very similar in men and women.

2. An item-specific factor is important in the first 17 cm. of movement, suggesting that the velocity curve may be of a two-component form.

3. Measured static strength available for a movement, and speed in that movement, are possibly correlated to a slight degree; the relationship is difficult to establish and too small to be of practical importance.

4. The low relationship between static strength and speed of movement supports the hypothesis of high neuromotor specificity.

5. Women have slower maximal speeds of movement than men. When equated for difference in arm length (by comparing the sexes with respect to angular speed of movement), the difference is small and of questionable significance.

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(Submitted 12/24/59)

Increased Response Latency for Complicated Movements and A "Memory Drum" Theory of Neuromotor Reaction[1]

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Abstract

The theory proposes a nonconscious mechanism that uses stored information (motor memory) to channel existing nervous impulses from brain waves and general afferent stimuli into the appropriate neuromotor coordination centers, subcenters, and efferent nerves, thus causing the desired movement. A consequent hypothesis requires that the simple reaction time will become longer when the response movement is required to be of greater complexity. Data obtained on college men and women, and 12- and 8-year-old boys, are in agreement with the hypothesis. Replacing a very simple finger movement with an arm movement of moderate complexity slows the reaction by about 20 percent; additional complexity produces a further slowing of 7 percent. The speed of the arm movement is considerably faster in college men than in younger boys or in college women. The correlation between reaction time and speed of movement averages approximately zero. Individual differences in ability to make a fast arm movement are about 70 percent specific to the particular movement being made; "general ability for arm speed" occurs only to the extent of 30 percent.

THE TIME REQUIRED for a muscle to begin to respond to direct stimulation is about .015 sec. A simple reflex response such as the eye wink is made in .04 sec., while the reflex to a blow on the patellar tendon requires about .08 sec. The simplest voluntary response to a stimulus (simple RT) requires .15 sec. under the most favorable circumstances; .20 to .25 sec. may be considered more typical. When complications such as discrimination between several stimuli and/or choice between several possible movements are introduced (disjunctive RT), the required time increases and may be as long as .50 sec. It should be noted that RT "is not the time occupied in the execution of a response; rather, it is the time required to get the overt response started" (11).

Theoretical Considerations

Early experimental psychologists considered RT to be a measure of the cumulated time required for a series of mental processes, including stimulus perception and the willing of the movement. This concept was gradually discarded during the period 1873–93 in favor of the idea that the stimulus simply triggered off a prepared reflex, the voluntary mental phase of the process being limited to the preparation, i.e., the development of a state of

[1] From the Research Laboratory of the Department of Physical Education. This investigation was supported by a grant from the Faculty Research Fund of the University of California.

readiness to make a specific planned movement. This is essentially the same as the modern view. A reaction cannot be broken up into a series of successive mental and motor acts. The response is a total reaction in which perception of the stimulus runs concurrently with the motor response, with much of the perceptive process and all the overt movement occurring after the reaction i.e., following the true RT, which is defined as the latent period between the stimulus and the first beginning of physical movement. Woodworth has traced the historical development of these ideas in considerable detail (10).

While the traditional prepared reflex theory of RT may be accepted in its general aspects, the present writer proposes considerable modification designed to recognize current knowledge of the neuromotor system and its control by the cephalic nervous centers. There is no reflex in the modern physiological use of the term, since a reflex must be nonwillful and not voluntary. There is probably not more than a minimal involvement of the cerebral cortex in the RT response, because the neuromotor coordination centers and pathways are chiefly cerebellar or subcortical without cortical termination (9). Perhaps in consequence of the neuroanatomy, neuromotor perception is extremely poor, although neuromotor coordination or kinesthetic adjustment (with the absence of perceptual awareness) is exceptionally well developed in humans (4).

Performance of acts of skill (even though relatively simple) may be assumed to involve neuromotor memory. This may be operationally defined as improved neuromotor coordination and more effective response, the improvement being the result of experience and practice, possibly accumulated over a period of many years. An implication of the neuroanatomy of the system as outlined above is that such memory must be different from ideational or perceptual memory, since conscious imagery is indefinite and largely excluded.

Nevertheless, a rich store of unconscious motor memory is available for the performance of acts of neuromotor skill. Added to this are innate neuromotor coordinations that are important in motor acts. The tapping of the store may be thought of broadly as a memory storage drum phenomena, to use the analogy of the electronic computer. The neural pattern for a specific and well-coordinated motor act is controlled by a stored program that is used to direct the neuromotor details of its performance. In the absence of an available stored program, an unlearned complicated task is carried out under conscious control, in an awkward, step-by-step, poorly coordinated manner.[2]

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[2]Subsequent to the preparation of this article the writer has become aware of an interesting observation by J. E. Birren: "When skills are acquired the component movements appear discrete and are then gradually combined into a continuous pattern. Furthermore, as a skill deteriorates (because of aging) it may again assume the quality of separate movements." (*Psychological Aspects of Aging,* Washington: American Psychological Association, p. 100; 1956).

Voluntary consideration of a particular movement that has already been learned, and is to be accomplished at maximum speed, occurs during the classical foreperiod (an interval of readiness while the subject is attentively waiting for the reaction-causing stimulus). Such consideration may involve visual imagery of the specific intended movement, but it is chiefly the development of a strong intent to start that movement in immediate response to the stimulus. It is not concerned (and indeed cannot be) with the actual formation of the already learned or structured specific program that will guide the released outburst of neural impulses through the proper centers, subcenters, and nerve channels so that it will produce the intended movement. The crucial willful act in the simple reaction is the release of the outburst of neural impulses that will result in the movement. Normally this act is voluntary and intentional rather than reflex, although in special circumstances it may become almost reflex. The term release is used advisedly; impulses are already present in the cephalic nervous system in the form of brain waves and afferent neural discharges from various sources and are directed and channeled rather than created. This is another point of distinction between a voluntary reaction and a simple automatic stimulus-response reflex.

The above concepts can lead to a number of testable predictions in the area of motor coordination. Keeping in mind that the programing of the movement can constitute only a part of the total latency (because synaptic conduction in and of itself requires time) it might, for example, be expected that a minor program change for a simple movement would be easy to accomplish, whereas a long or rather complicated program should be difficult to change after it starts organizing the channels. Various implications of the theory will be examined in subsequent articles.

Problem Investigated

One of these implications, which will be investigated in the present study, is the theoretical requirement that there should be a longer reaction latency for a complicated movement than for a simpler movement. This is because a more comprehensive program, i.e., a larger amount of stored information, will be needed, and thus the neural impulses will require more time for coordination and direction into the eventual motor neurons and muscles.

The voluntary decision to make a movement when the stimulus occurs is thought to cause a state of readiness to respond to (and be triggered by) the stimulus. During this foreperiod, there is some amount of preliminary neuromotor response. It is known that some premovement tension may develop in the muscles that are to make the overt response, but such tension is sometimes absent and sometimes of an inappropriate nature (10). Action potentials, however, reveal fairly consistent foreperiod excitation of both the reacting and noninvolved muscles. It is argued here that this may indicate alertness rather than implicit or partial reaction (11). Whether this interpretation is correct or not, it seems obvious that when the movement is complicated and

requires considerable skill, it is not possible for the tension during the foreperiod to be related to more than the very first phase of the overt movement. Moreover, a complicated movement necessarily involves several muscle groups and several specific areas of neuromotor coordination centers; more extensive use of learned and stored neuromotor patterns are surely required to initiate the overt motor action in this case. Thus it may be hypothesized that with richer and more complicated patterns involved, a longer latent time for the more complicated circulation of neural impulses through the coordination centers is inevitable. The situation is probably analogous to (but not identical with) the events, whatever they are, that cause greater response latency when there is a choice of movement in the reaction (10).

The hypothesis can be tested experimentally by observing the simple RT required for the initiation of movements that vary from simple to complex. Note that there can be a simple RT for a complex movement. If the situation for a particular response involves no discrimination as between two or more stimuli, and no choice (at the time of reaction) between which of two or more movements is to be made, the RT is simple, regardless of the complexity of the movement itself.

Review of Literature

While there has apparently been no investigation which approached the problem from the point of view stated above, there have been, over the years, a few researches that are pertinent. The first was a study by Freeman in 1907, which reported that in drawing geometric figures such as a straight line, a circle, and a pentagon, the RT became longer as the figure increased in complexity (3). In explanation, it was contended that the cause was antagonistic muscular tensions originating from anticipation of the necessary movement reversals. Unfortunately, the data were only secured on four individuals, so although the results are statistically inconclusive, they are in the anticipated direction.

On the other hand, Fitts (2) stated in 1951 that "the latent time is independent of the rate, extent or direction of the specific movement required by the stimulus," basing his interpretation on the 1949 experiment of Brown and Slater-Hammel (1), although he cites some other references that are less directly related. It may be noted that the experiment in question involved only the variation of the length or direction of a simple movement; complexity was not studied.

Several reports from our laboratory have included data on the RT for movements that differ in complexity. Unfortunately, with respect to the present issue, the experimental designs were oriented to the problems that were being investigated; no attempt was made to control or balance out the practice effect. The most recent of these was by Mendryk (7), who used two movements that differed considerably in length and slightly in complexity. In subjects of three age groups ($N = 50$ in each), the RT's were .002, .004 and .009 sec. faster for the longer and more complex movement. However, each

subject had been given 50 trials with the short movement and 30 practice trials with the longer movement before the tabled values for the latter were recorded, so there may have been a considerable practice effect acting to decrease the RT and thus occlude the complexity effect.

Mendryk has made available to the writer his data for the last 20 trials with the short movement and the first 20 trials with the subsequent longer and more complex movement, which makes possible a comparison involving less of the practice effect. In his 12-year-old group the RT for the longer movement is .004 sec. slower than for the short movement ($t = 1.2$), in the 22-year-old group it is .009 sec. slower ($t = 3.8$), and in the 48-year-old group it is .006 sec. slower ($t = 2.2$). Thus while the effect is small, and not completely controlled as to practice, it is in the anticipated direction and is statistically significant for the two adult groups.

Methodology

Apparatus and Movements. A reaction key was mounted at the forward end of the flat foundation board of the instrument. This was a sensitive key; the weight of the subject's finger was sufficient to keep it closed. At the back end of the board an upright supported a red warning light at eye level. A silent control switch was operated by the experimenter out of sight of the subject. When it was turned to its first postion, the warning light came on. After a lapse of 1 to 4 sec. (in chance order), the switch was turned to the second position, which sounded the stimulus gong and simultaneously started the RT chronoscope. When being tested with Movement A, the subject simply lifted his finger a few millimeters, which permitted the reaction key to open and stopped the chronoscope.

Movement B was more complicated. A tennis ball hung by a string which placed it about 15 cm. above the reaction key and 30 cm. further back, away from the subject. In response to the stimulus signal, he reached forward to grasp the ball. When the ball was touched, the upper support end of the string pulled out of a switch clip, thus freeing the ball to permit a follow-through. A second chronoscope, which also connected to the reaction key, recorded movement time (MT). It stopped when the string pulled out of the switch clip.

Movement C was somewhat more complicated; it included a series of movements and reversals. A second tennis ball (C), also supported by a string and clip, was hung 30 cm. to the right of ball B. In response to the stimulus, the subject moved his hand from the key, reaching forward and upward to strike ball C with the back of the hand, then reversed direction to go forward and downward, touching a dummy push button on the baseboard to the left of the reaction key, and finally reversed again to go upward and forward, striking down ball B. This two-ball apparatus was illustrated in an earlier publication from this laboratory (5), which listed references to detailed descriptions of the device. It should be mentioned that the circuits included provision for

using an auditory stimulus (an electric gong), and this was used in the present study.

Experimental Design. There were two experiments. In the first, designated Experiment I, there was continuous rotation of conditions, trial-by-trial, with Movement A required for the first trial, B for the second, C for the third, A for the fourth, and so on. Before each trial, the subject was reminded as to which movement was to be made; moreover, he could see from the way the apparatus was set up that there were no balls, or one, or two, to be hit. Fifteen practice trials were given, followed by 30 trials (10 for each movement) which were used for the statistical analysis. While this design offered the advantage of very exact balancing out of possible practice and fatigue effects, there was a remote possibility that even though the instructions were carefully given, and the nature of the required movement for a particular trial was obvious, some cases may have occurred in which there might have been some element of choice of movement.

Experiment II involved one practice trial with Movement A, followed by 10 trials with that movement. After a brief rest, a practice trial was given on B, followed by 10 trials with that movement. After another rest, one practice trial was given on C, followed by 10 trials with that movement. A third of the subjects followed the A-B-C sequence, another third the sequence B-C-A, and the final third the sequence C-A-B. Each person had 30 trials (10 on each movement) in addition to the practice before each series of ten. All subjects used in Experiment II were well practiced in the movements, since they had gone through Experiment I aproximately one week earlier.

Subjects. Group 1 consisted of 30 undergraduate college men. Group 2 was composed of 30 undergraduate college women. In each group approximately half were physical education majors. These groups were tested only under the conditions of Experiment I. Group 3 consisted of 20 young men ranging in age from 19 to 35 years (average 24), and included college students, high school teachers, and others. Group 4 was made up of 20 eighth grade boys, age 11 or 12, and Group 5 was composed of 20 fourth grade boys age 8 or 9. Not one of these 120 individuals was (or could be) selected in any way, either intentionally or unintentionally, with respect to the possibility that he would do better with one of the movements than with another one. In other words, the samples are completely unbiased with respect to the variable under consideration, which is the RT for Movement A compared with B or C.

Results and Discussion

Reaction Time vs. Complexity. The data of Table 1 show that all groups react more slowly as the movement becomes more complex. The reaction preceding Movement B is about 20 percent slower, on the average, than the RT for A, and the reaction preceding Movement C is about 7 percent slower than the RT for B. Even though the groups are relatively small, the differ-

TABLE 1.—MEAN REACTION TIMES OF THE VARIOUS GROUPS

Group	Movement A		Movement B		B-A	Movement C		C-B
	M (sec.)	σ	M (sec.)	σ	t[a]	M (sec.)	σ	t[a]
1(I) Men	.163	.018	.195	.026	8.6	.204	.031	2.9
2(I) Women	.174	.027	.205	.026	8.3	.219	.034	3.8
3(I) Age 24	.158	.025	.197	.034	9.4	.213	.034	5.3
4(I) Age 12	.178	.023	.214	.035	8.1	.226	.033	3.4
5(I) Age 8	.238	.038	.275	.042	8.4	.295	.026	4.9
3(II) Age 24	.144	.019	.186	.031	10.1	.199	.032	3.4
4(II) Age 12	.159	.015	.201	.031	7.5	.214	.033	3.8
5(II) Age 8	.214	.031	.253	.024	7.0	.270	.039	4.0

[a] A t-ratio of 1.70 is significant at the 5 percent level for Groups 1 and 2 (N=30), while 1.73 is required for Groups 3, 4, and 5 (N=20). The statistical hypothesis is single-tailed, since the direction of the differences is predicted by the experimental, i.e., alternative, hypothesis. It will be noted that all of the t-ratios are significant and quite large; the smallest is 2.9.

ences between the RT's are without question statistically significant in each, as may be seen by the t-ratios in Table 1. Moreover, the differences are approximately as large and significant under the conditions of Experiment II as under the conditions of Experiment I.

Since the findings are positive in each of five groups of subjects that differ in age and sex, and are positive under both of the experimental conditions, the evidence seems adequate to claim that the hypothesis of slower RT for movements of increased complexity, based on the memory drum theory of reaction latency, has been confirmed. It should be emphasized that the simple movement was very simple indeed. Furthermore, the amount of movement required to actuate the reaction key was only a fraction of a millimeter; in other words, the RT did not involve movement in the ordinary meaning of the word. (Some experiments that have purported to measure RT have actually included considerable amounts of movement). The additional serial elements and reversals of direction in Movement C, as compared with B, caused only about a third as much change in RT as did the type and amount of complexity difference of B as compared with A.

The determination of the crucial elements of the complexity effect, and of just how much of a change in complexity is required to produce a noticeable change in RT, will require further investigation. It seems reasonable to expect that increased movement complexity occurring early in a movement will have a much greater influence on RT than if the complexity appears late in a movement that was simple in its early phases. Whether increased demand for accuracy and precision of movement, and increased involvement of feedback, will slow RT as implicitly predicted by the theory, are among the important questions that remain to be answered.

Secondary Problems Investigated

Age and Sex Differences in Reaction Time. It will be noticed that RT is slower in the younger age groups (Table 1), although no statistical evalua-

tion of the differences has been made because the influence of age on RT is already well established (11). This is not true in the case of MT. Data on that problem have only become available recently (7, 8); the current results will be given in the next section of the report.

In the present set of experiments, the RT's of men and women subjects do not differ significantly. The t-ratios for the differences are 1.7 for A, 1.5 for B, and 1.7 for C; these are within the expectations of random sampling variability. As might have been hoped, the two samples of adult males have very similar RT's, the differences within each movement condition being nonsignificant ($t = 0.8$, 0.3, and 0.9). It may be seen in Table 1 that RT's are faster for all ages in Experiment II as compared with Experiment I; this is of no consequence because these subjects necessarily had practice in the reactions and movements before doing Experiment II (since they had already done Experiment I), and would be expected to profit by that experience. The amount of practice was of course equal for all three movements.

Age and Sex Differences in Movement Time. The mean movement times are given in Table 2. In Movement B the 8-year-old boys are 52 percent slower than the 12 year olds in Experiment I, and 27 percent slower in Experiment II. In the case of Movement C, the figures are 54 and 33 percent. All these differences are significant. However, the differences between the 12-year-old boys and the 50 adult males are not significant; the t-ratios are 0.9 for B and 1.1 for C and hence fail to overthrow the null hypothesis. The two samples of adult males do not differ significantly one from the other, either for Movement B ($t = 1.9$) or Movement C ($t = 1.6$). It will be recalled that Movement A was not timed, because it was simply a finger withdrawal.

The college women are 40 percent slower than the college males in Movement B and 14 percent slower in Movement C. These differences are clearly significant, as evidenced by large t-ratios (Table 2).

Intercorrelations. The correlation between RT and MT varies considerably among the five groups of subjects, which is not unexpected because the num-

TABLE 2.—MEAN MOVEMENT TIMES OF THE VARIOUS GROUPS

Group	Movement B			Movement C		
	M (sec.)	σ	t (groups)	M (sec.)	σ	t (groups)
1(I) Men	.093	.024		.481	.079	
2(I) Women	.130	.027	5.6(#2-#1)[a]	.552	.094	3.1(#2-#1)[a]
3(I) Age 24	.078	.029		.437	.103	
4(I) Age 12	.097	.023	2.1(#4-#3)[a]	.493	.108	1.6(#4-#3)
5(I) Age 8	.147	.043	4.5(#5-#4)[a]	.762	.131	6.9(#5-#4)[a]
3(II) Age 24	.081	.013		.391	.161	
4(II) Age 12	.091	.021	1.8(#4-#3)	.438	.208	0.9(#4-#3)
5(II) Age 8	.117	.026	10.3(#5-#4)[a]	.582	.103	2.7(#5-#4)[a]

[a]A t-ratio of 2.0 is significant at the 5 percent level.

ber of cases in any one group is rather small for this type of analysis. The relationship has been examined for Experiment I only. For Movement B, the values range from —.323 to +.212, with the average (using the z transformation) at r = .064. In the case of Movement C, the values range from —.088 to +.420, with the average at r = .180. There seems to be no particular tendency for the amount of correlation to vary systematically with age or sex. These results are in agreement with the findings of others, which have recently been reviewed (6, 7). The problem here is not really whether the correlation is or is not statistically significant, since it might or might not be found significant in one particular study. Rather, the concern is whether the real correlation is low (tending to be close to zero), or substantial, i.e., moderate, or relatively high. Evidence is accumulating that it is a very low order relationship, having little or no predictive value.

The correlation of MT itself as between the B and C types of movement is somewhat higher. It is true that for age groups 8 and 12 the values are very low, namely, .084 and —.002. However, in the adults the figures are .562 for the women, .489 for the college males, and .427 for the group of 20 men. When the five groups are averaged (using the z transformation), r = .329. While the correlation may be considered significantly different from zero for each group of adults, their average value (.493) certainly does not indicate a high degree of relationship.

The odd-even MT reliability coefficients (S-B corrected) for the three groups of adults are .982, .919, and .796 for Movement B and .988, .966, and .684 for Movement C. Using these values to correct the correlations between the two movements is r^2, which is .326, 269, and .335 in the above three relationship after the influence of error variance (unreliability) has been removed.

Now the amount of common variance of individual differences as between the two movements in r^2, which is .326, .269, and .335 in the above three groups of adults. (These values may be multiplied by 100 to convert them to percent). It follows that the amount of individual difference variance that is not common to the two movements, and is not error variance, is given by the squared coefficient of alienation k^2, which is defined as $1\text{-}r^2$. It is obvious that k^2 is to be identified as the specificity of individual abilities in the two movements, while r^2 is the generality of individual abilities. The values of k^2 for the three groups are .674, .731, and .665, and may be converted to percents by multiplying by 100. The relatively large values for k^2 justifies the statement that ability to make a fast arm-hand movement of the type used is quantitatively determined to a greater extent (69%) by abilities that are specific to one or the other of the two movements, and to a lesser extent (31%) by a general speed ability that is involved in both movements. This analysis has, moreover, presented the most favorable case for generality, since it has been limited to the three groups of adult subjects; the correlation between movements approximated zero in the younger groups. The results

with adults agree with those of a recent study that utilized other types of arm movements, finding 74 percent specificity and 26 percent general arm speed ability (7).

Summary and Conclusions

Following a consideration of prevailing concepts of reaction time and modern knowledge of the operation of the neuromotor nervous system, a theory has been developed which places heavy reliance on nonperceptive use of motor memory in voluntary acts involving motor coordination. Innate and particularly learned neuromotor coordination patterns are conceived of as stored, becoming accessible for use in controlling the act by a memory drum mechanism that requires increasing time for its operation as the motor act becomes more complex.

To test the hypothesis that the simple reaction time becomes lengthened with increased movement complexity, data were secured on 120 individuals, including both sexes and (in the case of males) three age groups. Sixty of the subjects were tested with two experimental procedures in order to improve the adequacy of the control conditions. Three types of movement varying in complexity were used; both reaction time and movement time were measured.

The data were also examined with respect to several problems secondary to the main study. These included the influence of age and sex on net movement time, and the amount of generality and specificity of individual differences in speed of arm movement ability.

Results of the statistical analysis of the data seem to justify the following conclusions:

1. Under controlled conditions, simple reaction time becomes longer when the type of movement which follows the reaction is varied from very simple to relatively complex. Further increase in complexity produces additional slowing, but to a lessened degree.
2. College women have less arm speed ability than college men.
3. Eight-year-old boys have less arm speed ability than 12-year-old boys. (While the data suggest that 12 year olds are slower than young adults, the statistical results are inconclusive.)
4. Individual differences in speed of arm movement ability are predominately specific to the type of movement that is made; there is only a relatively small amount of general ability to move the arm rapidly.

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Influence of Motor and Sensory Sets on Reaction Latency and Speed of Discrete Movements

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Abstract

College men and women were tested as to reaction time and speed of an arm movement using both motor-oriented and stimulus-oriented set. The results confirmed a hypothesis based on neuromotor coordination theory that predicted slower movement and greater reaction latency when the motor set was used. However, the 20 percent of subjects who had a natural motor set tendency moved faster with an enforced motor set than with an enforced sensory set. The conditions of enforced set caused a moderate positive correlation between reaction and movement times. Women subjects reacted and moved slower than men, but were similarly influenced by the two enforced set conditions. Their natural set tendency was definitely stimulus-oriented, while men tended to have a neutral orientation.

THE THEORY of neuromotor coordination recently presented by the writer holds that the detailed motor components of a fast complicated movement are controlled by a nonconscious motor memory mechanism that programs the flow of nerve impulses through the appropriate centers and nerves to produce the desired motor act. According to this theory, attempts to institute conscious control of the movement will interfere with the programing, thus increasing reaction latency and tending to cause a poorly coordinated movement (4).

One of the hypotheses that follows from this theory is that the reaction time using the so-called motor set should be slower than it is under the conditions of the sensory set—in athletic parlance, concentrating on the movements of the start that is to be made in response to the gun will result in a slower reaction and a poorer start than concentrating on the gun and letting the movement take care of itself. Such a hypothesis is, of course, heresy; athletes and coaches alike are sure that the converse is true. They have always been taught so and can readily validate their faith by consulting a textbook.

The writer's search of the literature for statistically acceptable data, obtained under adequately controlled conditions and justifying an unequivocal acceptance of the prevailing concept, has proved to be a jousting at windmills. It seems pointless to cite and discuss the many references available on

[1] From the Research Laboratory of the Department of Physical Education. This investigation was supported by a grant from the Faculty Research Fund of the University of California.

the topic, since Woodworth has made an extensive and detailed review of the literature (8). It is noteworthy that the experiments have usually made use of only two or three subjects, and introspective analysis of the data has received more consideration than sampling error. Woodworth's evaluation of the available evidence is against the new hypothesis given above. "The muscular attitude is a single-minded readiness to react, while attention to the coming stimulus diverts a fraction of the energy" (8). This is essentially a drainage hypothesis. The present writer, examining the same evidence, contends that it is not adequate to support or deny either the new or the old hypotheses.

In our own field, there has been almost no research on the problem of motor vs. sensory set; the assumption has evidently been that it is already solved. There has been one study that touches on it, pointing to conflicting interpretations but giving no data (7).

Problem Investigated

The immediate problem is a statistically adequate testing of the hypothesis that adoption of the motor set results in slower reaction time than is the case with the sensory set. There are several related questions of interest. It would be desirable to know, at least on an exploratory basis, whether individuals tend spontaneously to adopt a sensory or a motor set, or perhaps vacillate or even have no clear set. It is possible that individuals who have a preference for the one set or the other tend to react and/or move faster when using the preferred set. There is the question of possible sex differences in the influence of these factors. All of these questions also need to be investigated with respect to speed of movement (or for convenience, its reciprocal, movement time.)

To approach these problems, it is necessary to decide what is meant by the term set. For the purposes of the present study it is operationally defined as the directing of the subject's attention toward the stimulus (sensory set) or toward the motor response (motor set) by means of the techniques that will be described.

Methodology

Apparatus and Movements. Reaction time (RT) and movement time (MT) were measured with a modification of the apparatus used in a recent study of movement complexity (4). The usual visual warning signal was followed by a foreperiod of 1 to 4 sec. (the time in any particular trial being ordered by chance). The reaction stimulus which followed was an electric gong. In response, the subject moved his hand laterally from the reaction key to touch a pushbutton placed 18 cm. to the right and continued the movement with an arm sweep to strike down a tennis ball suspended 30 cm. in front of the reaction key and 15 cm. above it. The string supporting the ball was held by a friction clip attached to a microswitch arranged so that touching the ball stopped the MT chronoscope, which had been started by the reaction key.

The RT chronoscope was of course started automatically with the stimulus and was stopped by the removal of the hand from the reaction key at the beginning of the movement.

Measurement of Spontaneous Set Preference. All subjects were naive; they were given three preliminary practice trials. Each subject was then given a series of 15 reactions using his natural set. After each single reaction, he was asked questions as to whether his attention had been directed primarily toward the stimulus he was expecting, or toward the movement that he was to make in response to the stimulus. At times there was, of course, no tendency toward either; at other times the subject asked what direction of attention was desired by the experimenter. The answer to this was designed to make clear to the subject that his own preference was to be followed. Each instance of stimulus-oriented response was given a score of one, whereas an instance of motor-oriented response was scored negative one. Since there were 15 trials, a subject's raw set preference score had a possible range of 15 to —15. For statistical convenience, this was converted to a positive score ranging from 15 (completely stimulus-oriented or sensory set) to zero (completely motor-oriented).

Following these 15 trials, the subject was given 40 trials with enforced direction of attention as will be explained below. Approximately a week later, he returned to the laboratory for a 15-trial retest on spontaneous set preference and another 40 trials under the enforced conditions.

Experimental Design for Enforced Set. The 80 subjects were evenly divided as to sex. Within each sex group, subjects were alternately assigned to subgroups A and B as they came to the laboratory. Following the initial 15 trials the A subjects were given a series of 10 trials with the sensory set, 10 with the motor, 10 more with the sensory, and 10 more with the motor. The B subjects were given the opposite sequence, namely, motor, sensory, motor, sensory. When retested one week later, each subgroup was reversed, i.e., the A subjects were given the B sequence, and conversely.

In a given subseries designated sensory set or motor set as the case might be, the subject was first given several practice trials with instructions to orient his attention in the desired direction. If the set was to be sensory, the instructions were essentially to concentrate on and be ready for the stimulus, being sure, of course, to start and complete the movement as quickly as possible since it was also being timed. For the motor set, the instructions were to concentrate on the movement to be made, starting as quickly as possible and completing the movement as rapidly as possible, but remembering to respond immediately to the starting gong since the holding down of the key was also being timed. Practice trials were given before each subseries until the subject felt he was ready to be tested. This typically required about five or six at first, with an eventual cutback to a single trial for most subjects later on in the experiment. After the practice, ten official trials were made. After each trial, the subject was asked if he had been successful in orienting his attention as instructed. If he had failed to follow the instructions, the results were

not recorded. Each subseries, therefore, consisted of ten trials made with the desired set (sensory or motor) insofar as this was possible of accomplishment by the method used.

Subjects. All were college undergraduates. The 40 men included 22 physical education majors; the 40 women included 22 members of the Women's Athletic Association (seven were physical education majors). The rest of the subjects were secured from activity classes. All were volunteers, and none had participated in a reaction-time experiment before. This group of subjects did not overlap with those used in the other recent study from this laboratory (4).

Results

Enforced Sensory and Motor Set. Both the men and the women subjects react about 2.6 percent slower and move about 2.1 percent slower when using the motor set as compared with sensory set (see Table 1). The women subjects react 13.9 percent slower than the men and require 30.3 percent more time for the movement. The data of Table 2 suggest that there is a consider-

TABLE 1.—DESCRIPTIVE STATISTICS FOR REACTION AND MOVEMENT TIME

Set	Reaction Time (sec)[a]		Movement Time (sec)[a]	
	M	σ	M	σ
Men				
Sensory	.198	.031	.237	.047
Motor	.203	.033	.242	.049
Difference	.005	—	.005	—
Women				
Sensory	.224	.032	.309	.061
Motor	.230	.038	.315	.058
Difference	.006	—	.006	—

[a] Each tabled entry represents the average of 40 trials for each of 40 individuals; the standard deviations apply to the variability between individuals.

TABLE 2.—INFLUENCE OF PRACTICE ON REACTION AND MOVEMENT TIMES

Test	Reaction Time (sec)[a]			Movement Time (sec)[a]		
	Sensory	Motor	Difference	Sensory	Motor	Difference
Men						
1	.203	.204	.001	.251	.255	.004
2	.197	.203	.006	.237	.243	.006
3	.196	.201	.005	.228	.236	.008
4	.197	.202	.005	.230	.233	.003
Women						
1	.235	.237	.002	.329	.333	.004
2	.229	.241	.012	.316	.323	.007
3	.216	.224	.008	.297	.306	.009
4	.217	.219	.002	.292	.299	.007

[a] A test score is the average of 10 trials per individual; tabled entries are average scores for 40 individuals.

able practice effect during the first three of the four subseries, and that the differential influence of set is almost nonexistent in the first subseries. These observations indicate the advisability of using the variance analysis method for determining the statistical significance of the differences.

Variance Analyses. An analysis of the total data is given in Table 3. The main effects are all clearly significant; the women are slower than the men in both RT and MT, the motor set results in slower RT and MT, and the practice effect is substantiated for both RT and MT. The only interaction of interest is that of subjects-by-set; this passes the conventional test for significance in the case of RT but is borderline for MT. This interaction implies that there are individual differences in the response of subjects to the two types of enforced set, a possibility that will receive further comment later in the article.

It is of interest to examine the results for the men and women separately. The analysis is given in Table 4. The effect of set is statistically significant

TABLE 3.—VARIANCE ANALYSIS OF TOTAL SUBJECTS AND CONDITIONS

Source of Variance	df	Reaction Time MS	Reaction Time F	Movement Time MS	Movement Time F
Total sum of squares	639	16.79	——	48.28	——
Sex	1	1174.24	13.54	8486.31	36.91
Subject w/i sex[b]	78	86.72	19.10	232.85	40.49
Set	1	42.80	9.43	50.68	8.81
Practice	3	54.29	11.96	274.43	47.73
Interactions					
Subj. x set w/i sex	78	6.80	1.50	7.40	1.29[a]
Within subjects[c]	478	4.54	——	5.75	——

[a] Indicated value is of borderline statistical significance; all other F's are clearly significant. Tabled entries are based on the average of ten trials per subject in units of hundredth seconds.
[b] Error term for the sex difference. An F of 3.96 is required for significance at the 5 percent level.
[c] Error term for all variances except the sex difference. This variance includes the practice x set x sex interaction, hence it is somewhat larger than the net variance within individuals (4.45 for RT and 5.71 for MT). Required F's for significance at 5 percent are 3.86 for set, 2.62 for practice, and 1.30 for subject x set interaction.

TABLE 4.—VARIANCE ANALYSIS WITHIN SEX GROUPS

Source of Variance		Reaction Time				Movement Time			
		Men		Women		Men		Women	
	df	MS	F	MS	F	MS	F	MS	F
Total sum of squares	319	13.15	——	17.17	——	27.92	——	42.18	——
Subjects	39	79.09	22.09	94.35	17.77	186.42	41.33	279.30	40.42
Set	1	16.11	4.50	27.44	5.17	19.60	4.35	31.81	4.60
Practice	3	4.31	1.20[a]	74.68	14.06	78.95	17.51	218.36	31.60
Interactions:									
Subj. x set	39	6.16	1.72	7.43	1.40[a]	8.17	1.81	6.61	0.96[a]
Prac. x set	3	0.91	0.25[a]	4.35	0.82[a]	1.88	0.42[a]	0.72	0.10[a]
Within subjects[b]	234	3.58	——	5.31	——	4.51	——	6.91	——

[a] Indicated values fail to be significant at the 5 percent level. Tabled entries are based on the average of ten trials per subject, in hundredth second units.
[b] Error term for all variances. Critical F values for 5 percent significance are 2.41 for practice and practice interaction, 3.89 for set, and 1.45 for subjects and subject interaction.

in both sexes and for both RT and MT. The practice effect is nonsignificant for RT in the men subjects, although it is clearly significant for the women, and is significant for both sexes in MT. It should be noted that interest in the practice effect is peripheral; in the present study practice is simply to be considered as a source of variance that needs to be controlled (as was accomplished by the balanced experimental design) and that needs to be treated explicitly in the analysis since it might otherwise occlude the influence of set. The subject-by-set interaction is statistically significant in the men subjects, but fails of significance in the women. The nonsignificance of the practice-by-set interaction simply means that the practice effect is statistically about the same for both the sensory set and the motor set.

Spontaneous Set Preference. The extreme sensory set preference is represented by a score of 15, indicating that all free trials were stimulus-oriented, while a score of zero means that all free trials were movement-oriented. A completely neutral preference or a 50-50 mixed preference, therefore, is represented by a score of 7.5. The data reveal that both sex groups tend somewhat toward a sensory preference; the median scores are 8.4 for men and 10.5 for women. The difference between the two is statistically significant ($\chi^2 = 8.2$). It is interesting that a few individuals show consistent extreme preferences; three women and one man were sensory in all 30 test trials, and two men were always motor in preference. There is a significant reproducibility in individual set preferences, since the correlation between the preference tests on the two days is r = .56 for men and .50 for women.

One hesitates, however, to use the preference scores in a correlational analysis, because these reliabilities are rather low, and a scatter diagram shows that there is a tendency toward bimodality. Instead, the most extreme 20 percent of individuals in sensory preference and the most extreme 20 percent in motor preference (within each sex) have been selected to form subgroups of 16 sensory individuals and 16 motor individuals.

The sensory set preference subgroup averages .014 sec. slower in RT under the enforced motor set condition than under the enforced sensory set condition (t = 2.9, which is significant). However, in the motor preference subgroup, the RT's do not differ significantly as between the two conditions of enforced set (t = 1.3), although the mean scores are .007 sec. *faster* under the motor-oriented condition. Both of these tendencies appear in the men and in the women, when their subgroups are examined separately.

Movement time in the sensory preference subgroup averages .103 sec. slower under the imposed motor set conditions than under the sensory conditions; the difference is statistically significant (t = 4.1). In the motor preference subgroup, the imposed motor orientation results in a significantly faster MT (diff. = .023, t = 2.8). Again, the tendency is found in both men and women.

Correlation between Reaction and Movement Times. The above findings show that even though the average of the total group is clearly slower with the

enforced motor set (Table 2), there are individuals (namely those with a motor set preference) who respond in a manner that runs counter to this trend. This is particularly noticeable in movement time. In the variance analysis, the subject-by-set interaction was interpreted as suggesting that individuals do tend to respond differentially to the enforced set conditions.

In the light of these results, it would be expected that one of the effects of enforced set should be to cause a correlation between RT and MT, since individuals with one type of set preference are reacting and moving more slowly under the enforced motor set, and individuals with another type of set preference are reacting and moving faster under that same condition. (Usually the correlation between RT and MT is close to zero.)

The data of the men and women have been combined for correlational purposes by equating the two sexes as to mean scores, done by subtracting the mean sex difference from each of the individual scores of the women subjects. Under the condition of enforced sensory set the correlation between RT and MT is $r = .306$, and using the motor set it is .349; both differ significantly from zero ($t = 3.1$ and 2.7). The difference between the correlations is also significant ($t = 7.4$). In evaluating this difference it is necessary to remember that both correlations are computed from the same sample of individuals; hence a special technique is required (6). The reliability coefficients are rather high, $r = .921$ for RT and .966 for MT, so there is no necessity to correct for attenuation.

Discussion

The factual results confirm the hypothesis and thus support the programing theory of neuromotor coordination. Adoption of the motor set causes the average subject to react slower and move slower, as compared with his performance using the sensory set. It is conceivable that the results might have been different had the movement been of the least possible complexity and extent; indeed the theory provides that the influence of the motor set on the programing process would be minimal or absent in that case (4). It may be noted that most of the earlier work on set emphasized a simple finger-press or finger-lift response (8). It is altogether possible that the influence of set may function through several mechanisms; thus the motor set may be advantageous in some circumstances. In fact, in the present study, there is ample evidence that some individuals did best with the motor set, even though the average individual did not do as well as he did when using the sensory set. Occurrence of these individual differences undoubtedly explains some of the findings in the older investigations.

On the other hand, in our field we typically deal with movements that are complex rather than maximally simple. The writer holds that the movements used in the present study are in essence more typical than finger pressing. Moreover, the facts that have been presented can only be interpreted to mean that the previously unchallenged generalization as to the advantage of the motor set has been overthrown.

On the critical side, with respect to the experiments that have been described, it should be pointed out that the subjects were not trained with either set for any long period of time. The results might be different after extensive training, although there seems to be no very sound theoretical reason for such an expectation.

It is possible to quarrel with the writer's definition of set. It is a widely used term; undoubtedly it has different connotations to different investigators. In this connection it should be emphasized that any defensible definition must apply to the sensory as well as the motor type. For example, the occurrence of muscle tensions or action potentials as an indicator of the presence of the motor set fails as a definition for this reason. It has been argued by others that the reason why a motor set results in faster RT is that there is an implicit or partial response by the muscles before the stimulus which releases the reaction (8). But muscular tension cannot at the same time be set and be the result of set. A different interpretation of the prestimulus tensions and potentials has been given elsewhere (4).

The operational definition used in this study has certain merits, as matters have developed. There were significant differences in both the RT and MT responses as between the sensory and motor conditions, and there were differential responses under the two conditions in subjects selected to be sensory or motor in their set preferences. It would not be very sensible to argue that there might have been a failure to achieve a difference in set in the face of this evidence, and of course no one would contend that the operationally defined motor condition actually produced a sensory set, and vice versa. The subjectivity of the set preference scores may be criticized; nevertheless, they did have a significant reproducibility and were related to statistically significant differential responses.

The matter of the correlations between RT and MT requires some further comment. With no control group in the present study, it cannot be claimed that the predicted occurrence of the observed low but significant correlations confirm the hypothesis—all that can be said is that the results are consistent with it. Also consistent is the fact that when no special conditions of set are involved, we have usually found these correlations to be close to zero in our other experiments using the same apparatus and similar movements. For example, in 50 comparable male subjects who received no instruction or orientation whatever with respect to set, the correlation was —.079 between RT and MT using a movement somewhat less complex than used here, and +.044 using a somewhat more complex movement. In 30 comparable female subjects, the values were .101 and .180. The weighted average for the 80 subjects and two movements is .035 (4).

Certain other investigations at this laboratory have revealed significant negative correlations between RT and MT when special motivation conditions are involved. Howell reported a correlation of —.369 in a highly tense group of subjects and —.489 in a less tense group, when a strong electric shock was automatically administered if the subject made a slow total response (5).

Such results are not really inconsistent with the theory. Rather, they illustrate that the correlation between RT and MT may ordinarily be close to zero, but special circumstances may cause it to be moderately positive or may cause it to be moderately negative.

The slower RT of women subjects is in agreement with the findings in other studies (1, 2), although the difference is not always significant when the groups are small (4). No satisfactory theoretical explanation of this sex difference in adults is available at the present time. The slower MT of women is less well known. In this experiment they were 30 percent slower than men; this is about the same as the average sex difference (27%) found in comparable subjects using the same apparatus and two similar movements (4). In another recent study using a quite different type of arm movement (a horizontal adductive arm swing of 90°), college women were 17 percent slower than college men, presumably because they had less strength available for the movment (3). Even though women are slower in RT and MT, the pattern of interrelationships and the influence of set on RT and MT is substantially the same in both sexes.

Conclusions

1. The theoretically-derived hypothesis that adoption of the motor set (as compared with the sensory set) slows RT and MT is confirmed. Under the conditions of the experiment, both speed of reaction and speed of movement average slower when subjects are required to use the motor set than is the case when they are required to use the sensory set.

2. There are individual differences in natural tendency to use the sensory set or the motor set. The reliability of this tendency is not high, but it is statistically significant.

3. Additional mechanisms as well as the one postulated are probably operative in determining the influence of motor and sensory sets. Individuals who have a natural tendency to use the motor set (as measured under free choice conditions) tend, perhaps, to react somewhat faster, and they move considerably faster, when using the motor set. This is contrary to the slower responses of the average person, or the individuals who have a natural tendency to use the sensory set, when they are reacting and moving under the motor set condition.

4. College women react slower and have a slower speed of arm movement than college men; their natural set tendency is more sensory than the almost neutral set tendency that characterizes men. The pattern of differential response to altered conditions of set is similar in men and women.

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Effects of Different Types of Hypnotic Suggestions upon Physical Performance

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Abstract

Ten young men in excellent physical condition and trained to meet specified criteria of trance depth (including ability to experience vivid visual and auditory hallucinations, to move about skillfully and naturally in the trance state, to carry out posthypnotic suggestions and, as the basic criterion, to undergo spontaneous posthypnotic amnesia) performed a standardized large-muscle exercise to exhaustion. The exercise: at set cadence pressing a 47-pound barbell from a supine position on a narrow bench. Performance was after receiving hypnotic suggestions in four conditions: (A) stereotyped suggestions in trance, performance in hypnosis; (B) pep-talk suggestions (urgent but not hysterical) in trance, performance in hypnosis; (C) suggestions in the trance to be activated posthypnotically by signal during exercise; and (D) posthypnotic failure suggestions to reduce performance out of hypnosis. The subjects had no conscious awareness of what, if any, suggestions were given to them in any of the conditions. Only condition D was significantly different from the others (1% level of confidence) and these scores were consistently worst. Of the remaining three conditions, best individual performance occurred in B (pep-talk) and no worst scores occurred in this condition. In the various hypnosis-fatigue studies attempted to date, only the failure-type suggestions seem to get results consistently.

ALTHOUGH MANY WRITERS on hypnosis have stressed the important role played by the specific suggestions and their mode of presentation to the subject or patient, apparently few efforts have been made to compare the effects of different types of hypnotic suggestions upon gross muscular performance. Consequently, there is little evidence as to whether either predominantly cognitive or affective types of suggestions are important factors in altering muscular performance.[1]

Procedures

The standardized exercise (supine press) employed in this study consisted in having the subjects lie at full length on their backs on a narrow bench and press a 47-lb. barbell to full arm extension as many times as possible. The width of the bench (11 in.) permitted full depression of the elbows so that the bar could touch the chest each time it was lowered. A metronome set the cadence for the presses (46 per minute); however, as the subjects

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[1] The suggestions were arbitrarily selected because the range of possibilities are enormous and there are, at present, no clear-cut guides as to their differential effectiveness in studies of this kind.

approached exhaustion, they were allowed to continue pressing as long as possible even though they could not maintain the cadence, just so they did not pause to rest or fail to achieve full arm extension. In explanation of this procedure, it should be noted that unlike most nonathletic individuals, athletes are likely to meet impending defeat in muscular performance testing with violent efforts to continue performing—even though there is no particular incentive involved other than the investigator's request that they do their best. All the subjects in this study forced a few additional presses without resting after the cadence was broken. In a previous study, one athlete repeatedly recovered during this period of forcing, resumed the cadence and went on to do more than 200 additional presses (2).

In detail, the subjects assumed the supine position on the bench, elevated their arms three times with the cadence, received the weight, and began pressing when ready. One investigator counted the presses audibly. Environmental temperature ranged between 73 degrees and 86 degrees F during the course of the 40 testings on the study; 33 of the tests took place with a temperature between 75 degrees and 80 degrees. Performance did not vary with the temperature. The testing of the study was done over a two-week period with no individual being tested more than once on any given day.

The subjects were ten athletes and/or physical education major students judged to be in excellent physical condition (six were wrestlers in very strenuous training, three were working out regularly, one was somewhat less active). The subjects had performed the supine press test sufficient times immediately prior to this study for their scores to plateau.

All of the subjects were carefully trained to meet specified criteria of trance depth prior to the experiment and had participated in at least two previous experiments. The minimum criteria of trance depth were: posthypnotic amnesia; ability to experience vivid visual, auditory, and olfactory hallucinations; ability to move about skillfully and entirely naturally while in the trance state; and ability to respond compulsively to posthypnotic suggestions. All of the subjects had also been trained to enter a trance immediately on request[2] and to signal their readiness to meet the criteria of trance depth and receive suggestions by hand levitation (spontaneous and automatic floating of a hand) to the face.

The conditions of the research were:

A. *Stereotyped suggestions,* used in a previous study (2).[3] Delivery of these suggestions was deliberate, quiet, and authoritative, with emphasis on

[2] They were, of course, also trained to enter a trance only when such behavior was entirely appropriate.

[3] "The purpose of what I am about to say to you is to help you to become psychologically adjusted for maximum performance on the physical performance tests that you're about to take.

"(Name) You are actually *much* stronger than you have realized, because as with most people you have muscular potentialities that you do not ordinarily draw upon even when you try your best. This is why very frightened and very angry people sometimes perform such amazing feats of strength. (*Continued on next page*)

"developing a state of mind" by verbal appeal. Performance was in the deep trance state.

B. *Pep talk suggestions.* These suggestions were intended to stir up the subjects by appeal to their egos.[4] They were given in an urgent, rather excited, but not loud or hysterical, manner. Performance was in the trance state.

C. *Posthypnotic suggestions.* The suggestions were given in the deep trance state but were to be acted upon out of the trance while performing the exercise. The posthypnotic suggestions were to the effect that when fatigue set in during exercise the investigator would begin urging the subject to keep going. This urging would constitute a posthypnotic signal (comparable, for example, to a tap or other signal which could be used to bring on visual hallucinations) that would have a refreshing, invigorating effect—as though the barbell suddenly became lighter.

D. *Posthypnotic failure suggestions.* The subjects were told that although they would make a maximum effort, they could not possibly do as well as usual; that they would think that by mistake or design additional weight had been added to the barbell; and that fatigue would begin earlier and be more severe than usual. The suggestions were made once as quiet statements of fact. Performance was out of the trance state.

The order of the conditions was rotated from subject to subject. That is, subject 1 moved through the conditions in the order A, B, C, D; subject 2, B, C, D, A; etc. Out of hypnosis the subjects were not aware of what suggestions, if any, were given to them in any of the conditions (posthypnotic amnesia), nor were they aware of the purpose of the study.

Results

Performance of all subjects in condition D (posthypnotic failure suggestions) was markedly worse than that in the other conditions.[5] Statistical

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"In the muscular performance tests that you are about to take, let's see if you can perform at your *full* potential. (Name) Begin *now* to have a feeling that it is *tremendously* important that you make the best possible score on each test. Begin now to feel as though the success of a whole team or saving your own or someone else's life depends on *your* performance in these tests. Your strength, endurance, and power will be tremendous. You will be so desperately anxious to succeed that fatigue will not bother you as it usually would. You won't care about it or notice it. The discomfort of fatigue usually stops people before they *have* to stop. But you will be able to keep going on the endurance test much longer than you ordinarily could because you are so strong and fatigue won't bother you. Do you understand, (Name)? Very well. Rest there quietly for a little while and in a few minutes you'll take the tests. You'll be *much* stronger and much more powerful than usual."

[4]For example: "You've done pretty well before, but this time you're going to show what you're made of—what you really can do. You'll be able to keep going much longer and you won't care about feeling tired. You won't notice it. And when you think you can't do any more you'll just keep on going," etc.

[5] During testing in condition D, as the subjects began to tire sooner than usual, they would glance anxiously at the barbell weights, try desperately to continue, and when they finished they expressed wonder at and/or apologized for their poor performance.

analysis of the data revealed no significant differences among conditions A, B, or C, but a very significant difference (at the 1% level of confidence) between condition D and the others.

All of the subjects scored the same or higher in condition B (pep talk) as compared with condition A (stereotyped). Although the most marked improvements in the study were found in condition B, only a tendency toward statistical significance was found when the means of B and A were compared. The mean of condition B was somewhat larger than that of condition C (posthypnotic signal) but the difference did not approach statistical significance.

Comments of the subjects indicated that they felt that the urging during exercise helped them (they were not aware that the urging was a posthypnotic signal.) They could not account for their poor performance in condition D (failure), since they were not, in the nonhypnotic state, aware of having received these suggestions. They were puzzled and more or less upset by this performance (as would be expected of athletes), and they rationalized it on the basis of being sure that the barbell was heavier than usual or that for some reason they just were not up to their usual ability.

Discussion

It has been suggested previously (1, 2, 3, 5) that trance depth, the physical fitness level of the experimental subjects, the duration and strenuousness of the work, and the kinds and manner of presentation of the suggestions given may be among the factors which affect performance in hypnosis-fatigue studies. The present investigation—which involved physically fit subjects, standardized short-duration work to exhaustion, and varied suggestions—revealed the usual lack of consistency in response of the subjects except in regards to the posthypnotic failure suggestions. Findings in this connection were clear-cut and in accord with a great deal of previous experience by these and other investigators. (An interesting example is a subject in a previous study (2) who improved his performance about threefold when hypnosis was induced and was therefore discarded from the study in terms of statistical analysis; he also responded helplessly to posthypnotic failure suggestions.)

At this early time in hypnosis-fatigue studies, it apparently can be said that verbalizations of the nonhypnotic, hypnotic, and posthypnotic kinds used so far cannot, under conditions such as those described here, be counted upon to improve performance in short-duration work. On the other hand, verbalizations of a failure variety which penetrate the organism at what have aptly been termed hypnotic levels (4) may be counted upon to be effective, hypnotically or posthypnotically. In the interests of future research, one may speculate as to whether the so-called hypnotic levels of the oragnism may, at certain ages and/or under various conditions, be accessible to failure type verbalizations even though no trance state as such has been induced.

Appendix

RAW DATA

(Expressed in the number of supine presses completed)

Subject	Body Weight (in lbs.)	Condition			
		A	B	C	D
1	145	43	44	48	41
2	195	43	50	41	31
3	125	43	50	45	31
4	135	52	52	50	32
5	140	46	46	48	35
6	145	52	52	56	39
7	150	53	58	57	46
8	138	48	48	47	29
9	158	42	44	42	34
10	140	47	50	47	33

ANALYSIS OF THE DATA

Condition	A	B	C	D
N	10	10	10	10
M	46.9	49.4	48.1	35.1
σ	4.01	4.00	4.94	4.98

T-RATIO

	σmd	T
A with B	1.88	−1.3297
A with C	2.12	−0.5660
A with D	2.13	−5.5399[a]
B with C	2.11	0.6161
B with D	2.12	−6.7452[a]
C with D	2.12	−6.1320[a]

1% level—2.861   5% level—2.086

[a] Significant difference

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Effects of Exercise on Swimming Endurance and Organ Weight in Mature Rats

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Abstract

In an effort to study the effects of exercise on swimming endurance and organ weight, mature rats were divided into two groups. One group continued to be inactive while the other was allowed to exercise at will in individual cages. After three months the animals were forced to swim as long as they were able with 6 percent of the body weight attached. They were then sacrificed, and the organs were weighed. There was no evidence that spontaneous activity influenced organ weight or swimming endurance. It is suggested that the lack of effect may be due to the fact that (1) the animals were mature at the start of the experiment and (2) the amount of exercise taken voluntarily at the termination of the experiment was much less than had been the case when the animals were younger.

ONE OF THE problems in studying endurance in humans is the difficulty or impossibility of exercising subjects to exhaustion. Lack of control of the many factors which influence conditioning and inability to measure accurately organ development impose further limitations on research with humans. On the other hand, the applicability of animal research to humans is always open to question. Because it is well known that humans respond to exercise training programs with increased capacity for work, an experiment was designed to study similar training in rats. Most previous work has been done with growing animals. In instances in which a comparison was made between wild and domestic animals, the wild animals had had the opportunity and, in fact, it had often been required for them to exercise vigorously at an early age. Hence, it was of interest to know what effects would occur when animals were allowed to mature before permitting any exercise.

Apparently there has been no research on the effects of spontaneous exercise on endurance swimming. Likewise, no data have been reported on the relationships between endurance swimming time and organ weights.

Considerable work has been done on the effects of exercise on organ weight. A summary of previous work is presented in Table 1. Despite these studies, much confusion still exists. This is especially true with regard to the liver, spleen, and testes. There are many reasons for the confusion. First, the data reported in the earlier studies were not analyzed statistically. When organ weights of two groups of animals are compared, one would not expect the means to be precisely the same. Converting the difference to a percentage does not help matters. Second, it is reasonable to expect a difference in the effect of spontaneous exercise (which has generally been running) and forced exercise (which is usually in the form of swimming either with or without

weights attached). Third, in some of the studies, organ weights were reported as absolute weights while in others relative organ weights, i.e., in terms of the animal's body weight, were given. Conceivably these two procedures could produce different results since any changes in total body weight would be reflected in the animal's organ weight/body weight ratio. Fourth, in some experiments full-grown animals were utilized, whereas in others exercise was intiated when the animals were very young. Finally, there may be sex differences in the effects of exercise on organ growth.

Procedure

Fifteen litters of male albino rats (Sprague-Dawley) all born on the same day were raised from weanlings (about three weeks of age). There were two animals in each litter. During the growth stage, each animal was restricted to his small 5" x 5" x 12" individual cage where there was no opportunity for even moderate exercise. At the end of this period (five months), the litter mates were separated into two groups. The heavier animals in the litters were alternated so that one group did not contain any more than half of the heaviest animals. One group, called the sedentary group, continued to live in their individual restrictive cages. The animals of the second group were placed in individual cages with exercise wheels attached. These quarters were so constructed that the animals could move from the living quarters to the gymnasium at will and a counter recorded the revolutions of the wheel in either direction.

All animals were fed *ad libitum* from a stock diet. The temperature in the animal room was maintained between 70 and 72 degrees Fahrenheit except during the last stages when the temperature exceeded this slightly for short periods during a few days. No direct sunlight fell on the cages. There was no control over humidity.

Body weight was recorded for each animal before the experimental period began and again at the end of the experiment three months later. The three standard leads of the electrocardiogram were also recorded at these two periods.[1]

At the end of the three-month experimental period, the animals were forced to swim as long as they were able with 6 percent of the body weight attached. The water was maintained at body temperature during the swim. The swim was terminated when drowning was imminent, i.e., when the animal was submerged for about 15 sec. and seemed not able to regain the surface.

The animals were dissected several days to a few weeks later (except in one instance when the animal drowned; it was dissected immediately). Before dissection, the animals were weighted dry in air, immersed in detergent solution, and then weighed under water. The detergent was used to minimize the trapping of air in the fur and to wash out the oil in the fur. The animals

[1] The technique for taking ECG's and the results are described in detail in another paper being prepared for publication.

TABLE 1.—PREVIOUS STUDIES OF EFFECTS OF FORCED AND SPONTANEOUS EXERCISE ON ORGAN WEIGHTS[a]

Reference	Heart		Liver		Kidneys		Spleen		Adrenals		Testes	
	For.	Spont.	For.	Spont.	For.	Spont.	For.	Spont.	For.	Spont.	For.	Spont.
Young Male Rats:												
Donaldson (3)		+		+		+		+		+		−
Donaldson (6)		+		+		+		+		+		+
Hatai (8)		+		+		+		−		0	(0)	+
Kimeldorf & Baum (11)[r]	(+)				(0)		(+)		(+)			
Donaldson (3)		+		−		+		−		+		+
McClintock (12)		0										
Borovansky (1)	+		−		+				+		+	
Donaldson (4)		+		−		+		−		+		+
Adult Male Rats:												
Hearn (9)[b]	(+)								(+)			
Donaldson (3)		+		+		+		−		+		+
Young Female Rats:												
Donaldson (3)		+		+		+		−		0		
Donaldson (6)		+		+		+		+		+		
Donaldson (3)		+		+		+		+		+		
Borovansky (1)	+		−		+		+		+			
McClintock (12)		+										
Donaldson (4)		+		+		+		+		+		
Adult Female Rats:												
Donaldson (3)		+		+		+		+		+		
No Age Given; Rats:												
Van Liere (16)[r] male	(+)											
Van Liere (16)[r] fem	(+)											

Reference	Heart		Liver		Kidneys		Spleen		Adrenals		Testes	
	For.	Spont.	For.	Spont.	For.	Spont.	For.	Spont.	For.	Spont.	For.	Spont.
Dogs:												
Bruns (2)[c]		+		+		+						
Grober (7)[c]		+		+		+						
Junkersdorff (10)[c]		+		+		+						
Siebert (14)[c]		+		+		+		+				
Steinhaus (15)[r] (run)		+		−		+				−		−
Steinhaus (15)[r] (swim)	+		+		+		−		+		−	
Guinea Pigs:												
Petren[d]		+										

[a] In the body of the table + indicates increase, − a decrease, and 0 no change in organ weight due to exercise. If these symbols are in parenthesis, a statistical analysis of the data has been made. r indicates relative organ weight.
[b] Animals began exercise before full-grown (100-120 days).
[c] From Donaldson (5).
[d] From Steinhaus (16).

TABLE 2.—COMPARISON OF SEDENTARY AND SPONTANEOUS EXERCISE GROUPS IN SWIMMING ENDURANCE AND ORGAN WEIGHTS

	Sedentary		Spontaneous Exercise		Difference in Means	
	Mean	N	Mean	N	(Exercise-Sed.)	t
Endurance Swim (sec.)	206.3	15	215.2	10	8.9	0.34
Specific Gravity of Carcass	1.0356	13	1.0429	10	.0073	1.11
Final Body Wt. (gms.)	392.0	16	402.0	10	10.0	1.01
Wt. Gain During Exp. (percent)	19.2	15	24.5	9	5.3	0.48
Adrenals 10^4 (gm/gm of body wt.)	1.272	16	1.266	10	−0.006	−0.05
Kidneys (gm/gm of body wt.)	80.79	16	73.84	10	−6.95	−2.85[a]
Spleen (gm/gm of body wt.)	16.10	16	14.72	10	−1.38	−1.86
Liver (gm/gm of body wt.)	380.8	16	383.3	10	2.5	0.14
Testes (gm/gm of body wt.)	87.5	16	82.9	10	−4.6	−1.08
Heart (gm/gm of body wt.)	32.1	16	29.5	10	−2.6	−1.75

[a] Significant at the 5 percent level. See discussion.

were then dissected and body organs weighed immediately. The heart, liver, kidneys, testes, and spleen were weighed on an O'Haus balance to the closest hundredth of a gram. The adrenals were weighed to the closest tenth of a milligram on an analytical balance.

Through a laboratory accident unrelated to the experiment, some of the animals in the spontaneous exercise group were lost as well as a few in the other group. Hence, it was not possible to compare data on litter mates as was originally planned.

Results

A comparison of the endurance swim times and body and organ weights of the sedentary and spontaneous exercise groups may be seen in Table 2. Figure I shows the correlation between endurance swim time and body weight, specific gravity and organ weight measurements. None of these correlation coefficients were significant at the 5 percent level. The coefficients of correlation were computed after pooling the data of both groups, as there appeared to be no appreciable difference in their swim times (Table 2). In the scatter diagram, since separate symbols for the two groups were employed, the justification for pooling the data can also be seen.

Since a record of the total activity for each of the spontaneous exercise animals was available, this group was studied further. At four different periods during the experiment, the total revolutions of the cage since the last tabulation was recorded. This made it possible to construct Figure II, showing changes of activity with age. Each of the four points in the graph therefore represents an average of from 20 to 40 days of activity for each of the nine rats. The room temperature was controlled within a few degrees until the last part of the fourth period when the temperature exceeded 72 degrees on a few days. It is, therefore, possible that some of the decrease which occurred during the last period may have been due to an increase in room temperature rather than age per se. Coefficients of variation were computed for the four periods which were as follows: 29, 23, 26, 37.

The significant F of 8.24 with analysis of variance results (Table 3) indicates that rats differ significantly with respect to the activity taken. The rats which were relatively active when young were also the more active animals in later life. Differences in the amount of activity taken at various periods in life were also statistically significant.

Table 4 contains correlation coefficients between the amount of activity in miles per day and other measures for the animals in the spontaneous exercise group. Although four coefficients are over 0.4, none of them were statistically significant. This is not surprising in view of the small number of animals available for this analysis.

Discussion

It perhaps appears surprising that the spontaneous exercise group of animals swam only about nine sec. longer on the average than did the sedentary group. However, it should be remembered that although the rats in the

TABLE 3.—ANALYSIS OF VARIANCE FOR AMOUNT OF ACTIVITY AMONG SPONTANEOUS GROUP

Source of Variance	Sum of Squares	DF	Mean Square	F
Between Time Periods	20.57	3	6.86	46.9[a]
Between Rats	9.64	8	1.20	8.24[a]
Error	3.51	24	.15	
Total	33.72	...		

[a] Significant at the 5 percent level.

TABLE 4.—CORRELATION BETWEEN AMOUNT OF DAILY SPONTANEOUS EXERCISE AND OTHER MEASURES (N=9)

Measure	Correlation Coefficients[a]
Endurance Swim	−.147
Specific Gravity	.414
Body Weight	.009
Percent Wt. Gain	.443
Adrenals (gm/gm of body wt.)	.456
Kidneys (gm/gm of body wt.)	−.309
Spleen (gm/gm of body wt.)	−.487
Liver (gm/gm of body wt.)	−.327
Testes (gm/gm of body wt.)	.215
Heart (gm/gm of body wt.)	−.022

[a] r must be 0.66 or larger to be significant at the 5 percent level.

former group were allowed to exercise regularly, this consisted of running rather than swimming. From what we know about human research it is not unusual for highly skilled and muscular athletes who are successful wrestlers, football players, or basketball players not to do well in swimming.

It is somewhat surprising that the relative heart weight of the spontaneous exercise animals was not larger than that of the sedentary animals. Perhaps the effects of spontaneous exercise are not observed when the animals are almost full grown before they are permitted to exercise. Also, since the body weight of the exercise group was slightly greater, this reduces the relative organ weights. Previous studies using rats and other animals almost invariably showed larger hearts in the spontaneous exercise animals. The only exception was the study by McClintock. However, it should be noted in Table 1 that of all the studies on heart size in animals, only Donaldson (3) worked with adult rats. Furthermore, the difference he observed was not tested for statistical significance.

With regard to liver size, almost as many studies showed a negative effect of spontaneous exercise as a positive effect. Again, only Donaldson (3) worked with adult animals, and statistical techniques were not utilized to analyze the difference. There is still lack of evidence, therefore, that spontaneous exercise results in an increase in relative liver weight.

All previous studies have shown an increase in relative kidney weight in spontaneous exercise animals. One would expect with a greater amount of

exercise and, consequently, an increase in production of metabolites, that the kidneys would enlarge. Why a negative result appeared in the present study is not clear. The significant t value was due to the very small kidneys of one animal. The relative weight of the kidneys in this animal was only a little more than half the mean observed in the remainder of the animals. Eliminating this one animal in the spontaneous exercise group renders the t insignificant. When a number of t's are computed as was done in the present study, it is reasonable that one of these would be significant due to chance alone. Considering these various factors, it is our conclusion that the effects observed in the present study on kidney size were due to chance.

So little is known about the function of the spleen, other than its capacity to store red blood cells, that it is difficult to predict what the effects of exercise might be on the weight of this organ. About half of the previous studies have shown a decrease in size and half an increase with exercise. In the only studies with adult animals, Donaldson (3) showed a decrease with spontaneous exercise in male adult rats and an increase in female adult rats.[2] On the basis of the present study, there appears to be no evidence that spontaneous exercise among mature animals has an effect on weight of the spleen.

The insignificant effect of spontaneous exercise on adrenal gland weight was not surprising. The animals were not under stress such as occurs when an animal is forced to exercise. However, it is worth pointing out that Donaldson (3) did show larger adrenals in his adult male animals on spontaneous exercise, although again the difference was not tested for statistical significance. Perhaps the stress of inactivity may have resulted in larger adrenal glands in the sedentary group, and this may in turn have balanced any effect exercise might have had on the spontaneous group.

The literature on effects of exercise on weight of testes is even more confusing. Less work was done on the effects of exercise on this organ than the previous organs discussed. In the present research we attribute any differences between the two groups and among the various spontaneous exercise animals to be due to chance. It should be remembered again that the animals in the present experiment were not allowed to exercise until they were fully grown.

The low correlations exhibited in Figure I might also be explained by the influence of specific gravity. Although none of these correlation coefficients were significant, the negative correlation between specific gravity and swim time was about as high as any correlation between swim time and organ weight. It would have been better to swim the animals with the fur removed since the amount of oil in the fur may vary from one animal to the next and this could contribute to variations in swim time.

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[2] It is interesting to note that the relative spleen weight for the exercised animals was less and also the correlation between amount of spontaneous activity and relative spleen size was negative. These differences, however, were not statistically significant. Other data being prepared for publication contain evidence that forced exercise in mature rats results in a significantly smaller spleen.

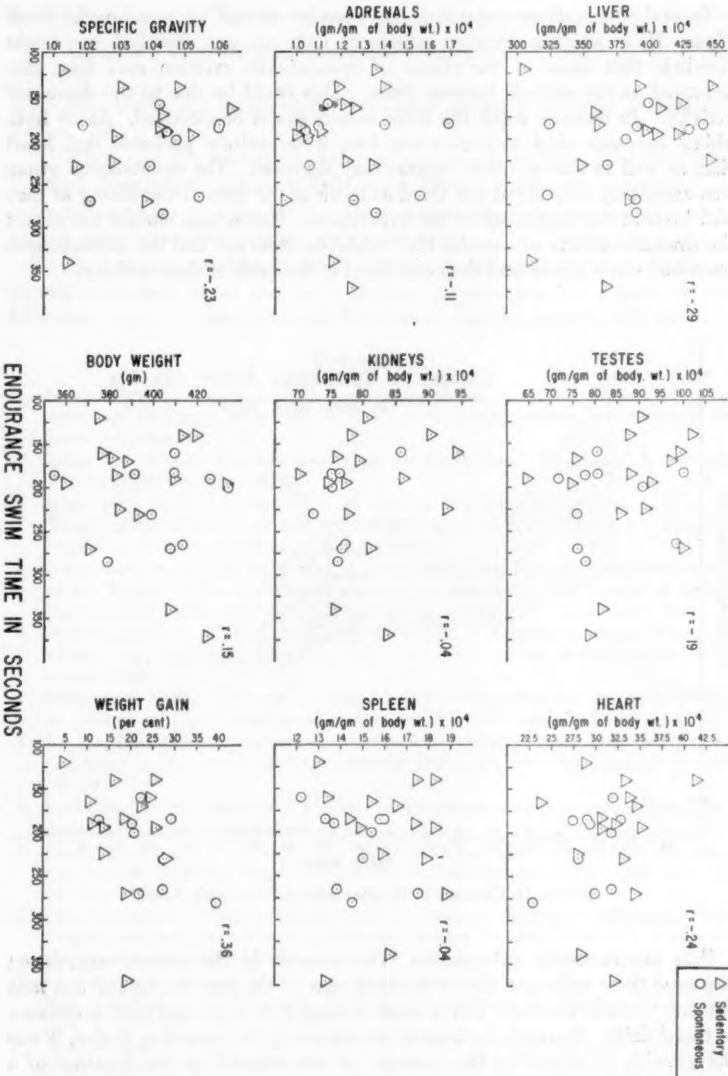

FIGURE I. Correlation of Endurance Swim Time and Organ Weights.

Several observations regarding the exercise should be mentioned. From Figure II, in which a decrease in activity with age was observed, one might conclude that some of the effects of spontaneous exercise may have disappeared as the animals became older. This could be due to the decreased activity. In humans much the same results might be expected. As an individual becomes older and exercises less, it is entirely probable that heart size, as well as size of other organs, may decrease. The spontaneous group was exercising only about one third as much at the time of sacrificing as they had been at the beginning of the experiment. Hence, one should not expect the dramatic effects of exercise that might be observed had the animals been exercised when young and then sacrificed at the peak of their activity.

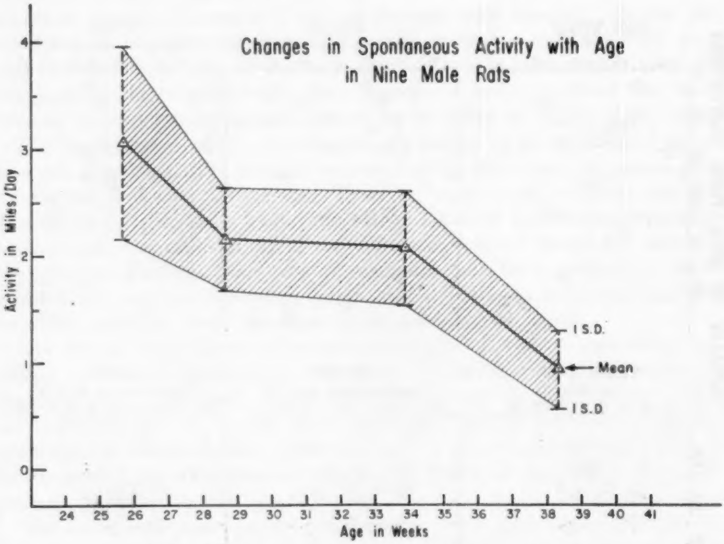

FIGURE II. Changes in Spontaneous Activity with Age.

Rats are normally quite active. The animals in the present experiment averaged three miles per day in the early part of the experiment and one mile per day towards the end. For a small animal, this is an appreciable distance to travel daily. However, because of the nature of the recording device, it was not possible to determine the intensity of this exercise or the duration of a single run before the animal rested. It is possible, particularly toward the end of the experiment, that the exercise was not strenuous and this, too, might account for the lack of effect of exercise on the various measurements.

Conclusion

1. There is a decrease in spontaneous activity with increasing age in mature rats.

2. Rats which are more active soon after maturity are also more active later in life.

3. When rats are allowed to exercise spontaneously only after they have matured, the exercise will show little effect in body and organ weights.

4. Spontaneous exercise in the form of running does not enable rats to surpass sedentary animals in an endurance swim.

5. In mature rats there is little correlation between performance in an intense endurance swim and body weight, carcass, specific gravity, or the following organ weights: adrenals, liver, testes, kidneys, spleen, and heart.

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Muscular Fatigue Curves of Boys and Girls[1]

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Abstract

Exponential fatigue curves for dynamic work of the forearm muscles were obtained from 200 boys and girls ranging from 8 through 17 years of age. The fatigue parameters analyzed in relation to initial strength were fatigable strength, steady-state equilibrium strength, and relative rate of strength loss per contraction. Older children were stronger and exhibited greater fatigue. When their strength loss and steady-state levels were considered in relation to their initial strength capacity, there were no age differences in fatigability, and sex differences were either absent or very small. At age eight, boys and girls had equal rates of strength loss per muscle contraction. Older boys, since they exerted more strength initially, tended to reach the fatigue level more rapidly than younger children. Older girls reached their fatigue level more slowly.

ONE OF THE DIFFICULTIES facing teachers of physical education skills arises from the fact that activities of the modern vigorous type cause considerable fatigue. One unsettled controversy among physical educators is whether the younger child should be given a less vigorous program, on the assumption that he fatigues more than an older child or a youth and therefore might be endangered by strenuous activity.

When a specialist in physical education attempts to make recommendations to implement a more active physical program, he cannot fail to be impressed with how little is really known about the basic physiological capacities of children. There is some reason to believe that the younger child may be just as capable in supplying oxygen to his muscles during exercise as the older child, when consideration is given to his body size. Although muscular strength has been investigated in children, there has not been much interest or activity in fundamental studies of their fatigability.

Review of Literature

Strength, Age, and Sex. Hand dynamometer grip strength has been studied for many years and offers a reliable strength measure. For example, Rogers (15), who used it in his test battery, found a coefficient of .92 for the right hand grip and .90 for the left. Further, it is worth pointing out that individual differences in forearm strength have been considered by some authorities as broadly representative of total body strength. For example, Bookwalter (3) states "grip strength is a likely component of strength batteries, a strength item in a 'fitness' battery, or a single item reasonably representative of total body strength."

Publications in this area clearly indicate that forearm strength is influenced by age and sex. It gradually increases until the middle or late teens; girls have less average strength increase with age and level off earlier than boys. These observations have been

[1] From the Research Laboratory of the Department of Physical Education. The writer is indebted to Franklin M. Henry for advice and encouragement, and for the design of the ergograph.

made by McCloy (12), Bliss (2), Madsen (14), McGinty (13), and others. Whipple (20), using the Smedley adjustable grip hand dynamometer, obtained forearm strength data on 3000 boys and 3000 girls, over an age range of 7 to 18 years. His data show that boys increase about 4 kg. in grip strength per year up through 18 years. Girls have an average yearly increase of 3 kg. and begin leveling off at 15 years. Jones (11) found that boys from ages 11 to 17 years have a yearly average grip strength increase of about 5 kg. Girls increase about 2½ kg. yearly and begin leveling off at 15 years. Bookwalter (3) reports similar results, but having used a larger age range, is able to show that in boys the increase in grip strength continues past 17 and up to age 23.

Fatigue. Very little investigation has been made in the area of voluntary muscle fatigue, particularly in its relation to strength, age, or sex. A strength decrement index has been proposed (5). At Iowa University, Tuttle and his students (4, 17, 18, 19) have studied static (isometric) grip strength endurance in boys and men. Strength endurance is defined by them as the average strength for a one-minute sustained contraction. Individuals with a stronger grip could maintain a higher absolute level of strength for the period investigated, but could maintain proportionately less of their maximum strength than weaker subjects. The younger individuals showed less initial strength and higher endurance. The form of the static fatigue curve and the effects of age on the rate or other quantitative aspects of fatigue were not studied. Royce (16), who has made a detailed mathematical and physiological analysis of the static fatigue curve in college men, did not investigate age effects or sex differences.

Grose (6) has studied muscle fatigue during isotonic (dynamic) work in college men. His subjects made repetitive maximum contractions of the forearm muscles for a period of six minutes, using a recording Smedley dynamometer as an ergograph. His study led to a mathematical basis for analyzing fatigue curves into their factors or curve parameters. These were found to be initial strength, final (steady-state) strength, fatigable strength (drop-off from initial to steady-state), and relative rate of decline per contraction (decrement rate).

Summarizing our present knowledge, it seems that strength in relation to age and sex has been well investigated. However, there has been little study in the area of voluntary muscle fatigue or endurance, especially with respect to dynamic work. It is difficult to apply available findings to the physical education program, because most of the muscular work done in typical activities is isotonic and repetitive in nature, rather than the short, sustained single-contraction type. It would seem that fatigue curves of the type studied by Grose (6) offer the possibility of revealing fundamental aspects of age and sex differences in fatigability that may have implications for the physical educator.

In view of Åstrand's (1) finding that younger children in the range of school ages seem to have just as adequate a maximal oxygen intake per unit body size as older children, it seems important to raise the question as to whether the younger child is not just as resistant to fatigue as the older child, when consideration is given to his capacity or ability to exert strength. The younger child has less strength, of course. This very fact limits and defines his muscular activity quantitatively. It can be hypothesized that fatigability, considered in relation to strength, should be independent of age and sex in school children.

The present study is concerned with testing the above hypothesis and with securing factual information on the initial strength, steady-state strength, and amount and rate of fatigue, with respect to dynamic muscular work in school children of both sexes and a typical range of ages.

Definitions

Initial strength represents the capacity of the individual to perform muscular work before fatigue has intervened to cause a reduction in work capacity.

Steady-state strength represents capacity to perform muscular work under conditions when fatigue and recovery have come to an equilibrium (other conditions being constant). *Fatigable strength* is the amount of drop-off in performance during the progression from the initial strength at the start of work to the fatigued condition at equilibrium. The *decrement* (curve constant k, as will be explained later) is the relative rate at which this drop-off in strength occurs during the continuation of the exercise.

Methodology

Apparatus. The newest model of the University of California type spring loaded hand ergograph is shown in Figure I. There have been a number of improvements as compared with the earlier model used and briefly described by Grose (6) and Royce (16). Basically, the instrument consists of an adjustable Smedley hand dynamometer (10) connected by a flexible cable to a writing lever that gives an 8 to 1 magnification of the hand movement. While a well-type pen was used in the present experiment, it has since been replaced by a bent ball point cartridge that seems to work satisfactorily. The lever is attached to a writing table and paper drive unit mounted on the side of a high speed model Correll Monodrum which gives a constant speed by virtue of its synchronous motor. An additional detail of practical importance is that the paper drive roller has a slight double taper, being about .060 inch larger in the center of its width. This keeps the paper recording tape centered without wandering.

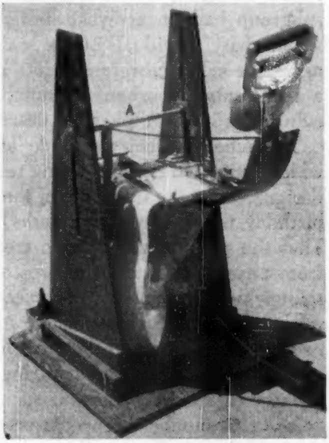

FIGURE I. Adjustable Grip—Strength Erogograph.

In order to improve stability of the base line, the hand dynamometer is attached to the recording unit with a semi-flexible mounting, as may be seen in Figure I. The motor-recorder-dynamometer assembly, which is fairly heavy, is hung by two supporting strips from a cross-tube, labeled A. A second tube, slightly longer than A, fits freely inside it, and bears against square washers at each end. A threaded rod and thumb nut, with outside washers, firmly clamps the inside tube and washers to the slotted wooden uprights, but permits 21 inches of vertical adjustment as desired.

The recorder-dynamometer unit is, in effect, hung like a pendulum from the cross-tube A. It therefore yields freely if the dynamometer is pushed or twisted. A metal washer is attached to the underside of the wooden base that supports the slotted uprights, so that the whole assembly rotates easily on the

floor if torsion is applied. As a result of using this hinged flexible attachment system, the recording lever responds only to squeezing of the dynamometer hand-grips, permitting a reasonable amount of shifting of the subject's arm position or aspect without invalidating the record. It may be noted that the hand-grips are padded with 1/8 in. rubber.

The instrument was calibrated against known weights and checked several times during the testing. No change was observed. The variable error for a single contraction was determined to be 0.7 kg., including the error in measuring the ink recorder trace on the paper tape (9).

Subjects and Experimental Design. Fatigue curves were obtained on 200 school children. There were 10 subgroups of boys and 10 of girls. Each subgroup had an age-year designation (from 8 to 17 inclusive) and consisted of 10 individuals of one sex who were within six months of the specified age. The subjects were students in the public schools of Albany, California, a representative urban community having many diversified economic and cultural groups. A physical description of the subjects is given in Table 1.

The school principals made available to the experimenter those classes which contained the ages being tested. From these classes, subjects were then designated by the teacher (on the basis of a show of hands as to who had a birthday within specified months) and sent to the testing room on schedule. Thus the subjects were drawn from the student body as a whole rather than from physical education classes or special program groups. There was absolutely no selection with respect to whether the children were strong or weak or had high or low endurance. In other words, the samples were unselected with respect to the dependent variables under study.

Testing was carried out during the regular school day. The variable influences of test environment, such as apparatus location, room temperature, noise level, number of people present, and other distracting influences, were minimized as far as possible.

Procedure. The importance of full cooperation and effort was explained to each subject, and an opportunity was extended to withdraw from the test. None withdrew. The instruction was emphatic to squeeze with absolute maximum strength each and every time the light signal flashed. Before beginning the exercise, the grip was adjusted to the individual hand size as specified by Whipple (20). A practice period of several contractions was given, using the nonpreferred hand for squeezing the experimenter's fingers. This enabled the subject to get the feel of making the contractions in rhythm with a metronome signal, set at 30 contractions per minute with relaxation following each contraction, and permitted the experimenter to be sure that the subject had mastered the procedure according to instructions.

Each subject was tested once on the ergograph for a period of 7 minutes (except for boys age 8, and girls age 8-11, who performed only 6 min.). Urging, coaxing, and encouragement were given to all subjects throughout the work period.

TABLE 1.—AGE, HEIGHT, WEIGHT AND GRIP STRENGTH OF THE TWENTY SAMPLES[a]

	Age (Yrs.)		Height (in.)		Weight (lbs.)		Initial Strength (kg.)	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
M	8.0	8.0	51.2	49.6	61.6	57.7	8.9	7.3
σ	0.32	0.24	3.1	2.2	8.6	10.2	1.8	2.3
M	9.0	8.8	54.0	52.8	68.5	63.6	12.6	10.1
σ	0.31	0.24	2.1	1.4	11.1	8.1	2.9	3.4
M	9.8	10.0	55.8	55.6	80.3	73.3	14.6	11.1
σ	0.23	0.11	3.2	1.9	15.6	4.2	1.5	2.5
M	11.2	11.1	57.2	58.6	93.4	92.2	18.2	15.4
σ	0.14	0.24	3.8	2.7	13.9	16.8	1.9	4.5
M	12.0	11.9	60.8	59.7	101.8	105.6	21.6	19.1
σ	0.33	0.32	3.3	3.5	21.7	19.1	4.5	3.8
M	13.1	13.1	61.2	62.4	119.4	120.2	22.5	21.0
σ	0.19	0.20	3.1	2.8	15.5	9.7	3.9	4.6
M	14.0	13.8	63.7	64.0	117.8	125.7	29.3	23.0
σ	0.30	0.26	2.5	4.1	20.1	17.3	5.8	3.5
M	15.0	15.0	63.9	65.0	121.0	128.9	29.6	22.3
σ	0.27	0.19	3.0	2.5	18.4	9.1	7.1	2.9
M	16.1	16.0	68.6	64.7	136.7	127.9	37.6	22.8
σ	0.32	0.27	2.9	1.9	14.6	11.2	3.1	3.4
M	17.0	17.0	67.8	65.3	148.0	134.8	38.6	25.2
σ	0.28	0.28	2.7	2.2	16.6	22.0	6.1	3.8

[a] Ten individuals in each sample.

Measurement of Individual Fatigue Records. Each subject's performance tape was measured with a calibrated scale card as to muscular force at evenly spaced sample periods, starting with the first contraction and measuring each fifteenth contraction thereafter. At each of these sample periods, three contractions were measured and averaged, in order to improve reliability. Because of the large amount of time that would have been required, no attempt was made to fit individual mathematical curves to the 200 performance records.

Subgroup Curves and Parameters. The mean value for the 10 subjects in each subgroup, at each of the 14 periods, was used to plot the points for the subgroup curves, using strength as the ordinate and number of contractions as the time axis or abscissa (see Figure II, left). Smooth curves were drawn through the points, being fitted by inspection, and an estimate made of the steady-state or final strength level (parameter C, steady-state strength). This value was subtracted from the strength score at each period, leaving a set of residual values representing strength above the steady-state at each measured point. These residuals were plotted on a semi-log graph (see Figure II, right), and a straight line drawn through the points by inspection. The intercept of this line at contraction number one gave the value of the parameter a_0 (fatigable strength).

The number of the contraction (less one) at which this line had dropped from its initial value to 1/10 that value (called tenth-time) was determined.

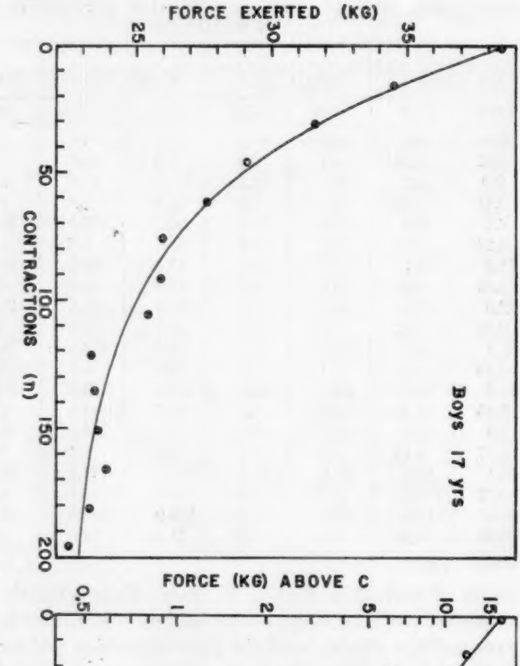

FIGURE II. Typical Fatigue Curve. The total curve is plotted arithmetically on the left. The fatigable component is plotted in a semi-log graph on the right.

This was divided into $\log_e 10$, which converted the tenth-time into the third parameter, namely the decrement rate constant k (in contraction units n). This method is the same as that described by Henry (8) and used by Grose (6).[2] These parameters apply to the formula

$$A_n = a_0 e^{-kn} + C$$

where the predicted strength A_n (after n contractions) is a function of the fatigable strength a_0, the decrement k and the steady-state level C. The initial strength A_0 may be calculated by the relationship $A_0 = a_0 + C$. The symbol e refers to the Napierian log base, i.e., 2.717. The decrement k is defined as $\log_e$ of the ratio of consecutive contractions (in units above C) at any point on the curve. It is therefore a measure of the relative drop-off in strength per contraction and is independent of amount of strength. This formula was used to compute the smooth curve in Figure II (left), using the parameter values obtained in Figure II (right).

Accuracy of Curve-Fitting. The fit of the data to the mathematical curve as shown in Figure II is typical of other subgroups. In some of them the fitting error is less and in some of them it is greater. The standard deviation of the 10 points about the fitted subgroup curve averages 0.53 kg. for boys (range 0.24 to 0.76 kg.). For girls, it is 0.41 kg. (range 0.15 to 0.56 kg.). In most of the curves, the obtained score for the first point falls *above* the smooth curve, suggesting that a more detailed exponential analysis might reveal the presence of a second exponential component of high decrement. The average residual for the first plotted point (which would correspond to a_0 for the second component) is 0.22 kg. for the boys and 1.70 kg. for the girls. This indicates that this component is only a negligible part of the total fatigue curve for boys and is relatively unimportant for girls. It will therefore receive no further consideration in the present study.

Results

Age Trends and Sex Differences. The effects of age and sex have been analyzed by plotting the subgroup curve parameters as a function of age for each sex and then fitting a linear regression line to the plotted data by the method of least squares. This is most conveniently done by considering each of the plotted points as a synthetic individual. The correlation between age and the variable under consideration is then computed and used to determine the regression coefficients as in a conventional correlation problem. Statistical methods are available to determine if the resulting regression line differs significantly from zero slope, or if the regression lines for the two sexes differ from each other.[3]

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[2] As a result of a typographical error, the formula as printed in the article by Grose is incorrect; A_n appears as a_n. However, his computations made use of the correct formula as given here.

[3] The formula for the F-ratio used to evaluate the difference from zero of the slope of a linear regression line is

$$F = \frac{ns^2_y \ [1 \text{ df}]}{ns^2_{\Delta y} \ [n-2 \text{ df}]}$$

where s^2_y is the squared standard deviation of the n points in the dependent variable y

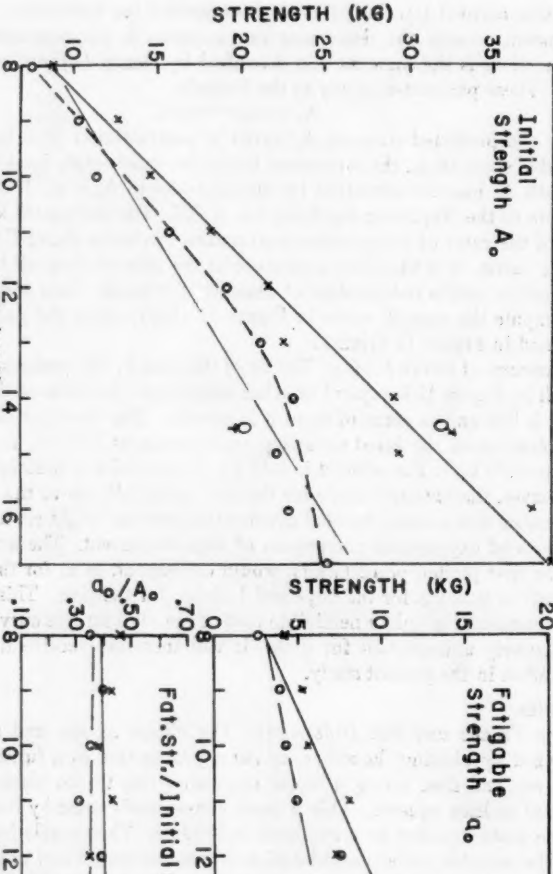

FIGURE III. Influence of Age on Initial Strength (left), and on Fatigable Strength and the Fatigue Ratio (right).

Initial Strength. The data on initial strength (A_o), plotted as a function of age, are shown in the left-hand graph of Figure III. It is easy to see that there is not much difference between the boys and girls at the younger ages ($t = 1.6$ at age 8), but after age 13 the girls show little further gain in strength with age, while the boys continue to become stronger. The curve seems to have a linear trend within the ages 8-17 for boys, the standard deviation of the points about the regression line being 1.38 kg., and the slope, 3.34.

For the girls, the standard deviation of the fitting errors is 1.67 kg. for the linear regression line, and 0.42 kg. for the curvilinear trend (drawn by inspection) that is shown in the figure by the dashed line. The F-ratio for the curvilinear gain in accuracy of fit is 15.85, compared with 3.44 required for significant at the 5 percent level, using 8 df. This furnished statistical justification for the belief that the girls are leveling off in strength.

Fatigable Strength. These data are also shown in Figure III. Fatigable strength (a_o) follows an upward linear trend with age for both boys and girls; the slope b is 1.438 for the boys and 0.628 for the girls. The t-ratio for the difference is 4.48, which is statistically significant. The fitting error is 1.632 kg. for the boys and 0.525 for the girls.

The ratio of fatigable strength to initial strength is plotted as the dependent variable in the lower right-hand part of Figure III. The ratio remains constant with age, showing no trend either upward or downward within each sex. This is confirmed by the statistical test. The F-ratio for the difference from a regression of zero is only 0.04 for boys and 1.01 for girls, compared with 5.32 required for the 5 percent level of significance. The difference in slope between boys and girls is also nonsignificant ($t = 0.56$).

The curve for the girls lies below the curve for the boys; they are relatively less fatigable than boys. Their mean ratio is 0.343 compared with 0.413 for the boys ($t = 3.67$, which is statistically significant). This outcome was unexpected.

Steady-State Strength. This type of strength (Figure IV) follows in general the same pattern with respect to the influence of age and sex as that found for initial strength and discussed above. The increase in steady-state strength (C) as a function of age within the range studied is obviously linear in the boys; the standard deviation of the errors in fit is 0.596 kg. In the case of the girls, it might seem that the trend is linear and of the same slope as in the boys up

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predicted from the regression line (rather than computed from the observed points), and $s^2_{\Delta y}$ is the squared standard deviation of the differences between the predicted and observed values for each of the n points. Note that s^2_y can be computed as σ_y^2 $(1 - r^2_{xy})$, using the correlation referred to above.

The slope b of the regression line is $r_{xy}s_y/s_x$. In this case, s_y is the standard deviation of *subgroup* means about their average in the dependent variable y, and s_x is computed from the subgroup age designations. (In the present problem, it has the value 2.872 yrs.). Using the subscripts 1 and 2 to identify boys and girls respectively, the t-ratio for the difference in regression line slopes is $b_1 - b_2/s_{diff}$. The denominator of this expression, squared, is the variance $(n_1 s^2_y + n_2 s^2_y)/df$, where the degrees of freedom are $(n_1-2) + (n_2-2)$. These statistical methods are explained by Hald (7).

to about age 13 or 14, after which it bends over to a nearby horizontal trend, as shown by the dashed line in the graph.

It is questionable, however, if such a curved regression line for the girls is statistically justified in the present data. The standard deviation of the errors in fit is 1.483 kg. for the linear line, compared with 0.857 for curvilinear regression. The F-ratio for the improvement in fit is 2.99, compared with 3.44 required for the 5 percent level of significance using 8 df. Therefore (in contrast with the results as to the trend for initial strength), the reduction in error by using the curved line is not statistically significant, although it might prove to be so by a more efficient statistical test. Comparing the two linear regression lines, the slope b is 1.999 for boys and 1.235 for girls. This is a statistically significant difference, since the t-ratio is 3.89.

The ratio of steady-state strength to initial strength is plotted in the upper right corner of Figure IV. Here again the boys tend to show a higher ratio on the average than the girls, 0.569 compared with 0.555, but this time the difference is not statistically significant ($t = 0.72$). There is no systematic trend in this ratio with respect to age within either sex. The F-ratio test shows that the slopes of the regression lines do not differ significantly from zero ($F = 2.78$ and 4.06, compared with 5.32 required for the 5 percent level).

Strength Decrement Rate. The rate constant (k) has been plotted as a function of age in the lower right corner of Figure IV. In these data, there is a suggestion of a slight upward trend with increasing age in the boys and a downward trend in the girls. The slopes of both regression lines differ from zero, since the F-ratio is 12.55 for the boys and 6.78 for the girls, compared with 5.32 required for the 5 percent level of significance. The slope coefficient b is .0002225 for boys and —.0003198 for girls; the t-ratio for the difference is 3.94. The k's estimated by the regression lines are identical at .0175 for both sexes at age 8, but diverge with increased age until at age 17 the k for boys is .0195 compared with .0148 for girls. This means that the older boys fatigue down to the steady-state at a relatively more rapid rate than the younger boys, while in contrast the older girls drop off in strength less rapidly than the younger girls and less rapidly than the older boys. These figures may be visualized more concretely by converting the k's back to tenth-times (explained earlier). The tenth-times (if stated in contraction units) represent the number of contractions required for 90 percent drop-off in fatigable strength. For 8 year olds, this is 132 contractions. It becomes 118 contractions for 17-year-old boys and 156 contractions for 17-year-old girls. This represents 11 percent faster fatigue for the oldest boys and 18 percent slower fatigue for the oldest girls, as compared with the 8 year olds (who showed no sex difference).

Discussion

The results as to sex differences and changes in initial strength with age are confirmatory rather than new knowledge of the age-strength relations, but they do agree closely with the results of Jones (11), and thus tend to

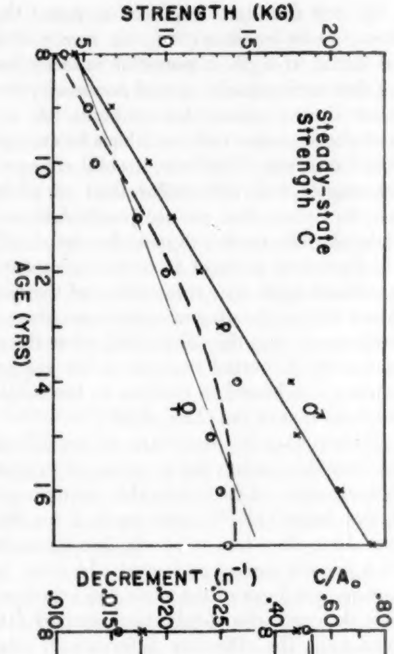

FIGURE IV. Influence of Age on Steady-State Strength (left), and on the Fatigue Ratio and the Strength Decrement Rate (right).

lend confidence to the new findings. It should be noted that initial strength is a necessary reference point in interpreting the results of the present study.

We must think of initial strength as potential capacity for muscular work. It must be conceded that such capacity would necessarily vary greatly among organisms of different size—a mouse, for example, has much less strength than an elephant, and the muscular tasks in which he engages must be appropriate to his own small strength. Similarly, a child engages in tasks that are appropriate to the strength of a child rather than an adult. It would seem reasonable, therefore, to believe that we are justified in evaluating the facts in relative rather than absolute terms; to consider the child's muscular fatigability in relation to his initial strength in order to interpret the age trends. The same reasoning should apply to a comparison of the two sexes.

The data have shown that in the present experiment, the younger child does not fatigue appreciably more than the older child, when the amount of fatigue is considered in relation to the initial strength of his age group. His steady-state strength also, when considered in relation to his initial strength, is not appreciably different from that of the older child.

In the youngest children (age 8), there are no sex differences in the relative rate of strength loss (k) during the progress of fatigue. As boys grow older, they lose relatively more of their fatigable strength per contraction, although the effect is not large (11.1% increase in k for the age range 8-17 yrs.). As girls grow older, they lose relatively less strength per contraction (15.4% decrease in k for the same age range). In other words, while girls do not fatigue any more than boys of the same age (relative to their strength capacity), older girls do reach the steady-state level of fatigue less rapidly than boys of the same age. The other sex difference in relative fatigue is in the ratio of fatigable strength to initial strength. Girls have 7 percent less relative fatigue than boys, regardless of age. (The ratio of steady-state to initial strength shows no sex differences.)

In relative terms, therefore, the experiment has shown that older children who are close to maturity are no more resistant to fatigue than younger children. The older girls, however, do approach the fatigue level more slowly than the younger children of either sex, and the older boys approach it somewhat faster. This difference may be the result of motivational-cultural rather than physiological factors. It is a common observation among experienced high school physical education teachers that the cultural pattern for these ages results in greater motivation toward demonstrating physical prowess in the males. The opposite situation seems to be present in the females as they mature. If this holds to even a moderate extent on the average, it could have enough influence to cause relatively greater exertion in the older boys in their first few muscular contractions on the dynamometer. Having done more work in the very first part of the fatigue curve than would have been the case had their effort been less, there would not be as much energy left for succeeding contractions. The fatigue curve would therefore tend to fall more rapidly. The opposite situation would function in the case of the girls, and thus tend to

result in a slower fatigue rate. One cannot say that the above cause of the difference has been proven. It is only a plausible explanation of the facts that have been observed in the experiment.

Caution must be exercised to avoid over-generalizing from the results of the present study. It would seem obvious that no research should be fully accepted until the results have been confirmed by others. Equally important, the observations need to be extended to other muscle groups, as for example the large muscles of the legs and thighs. Special apparatus for this purpose will need to be developed.

It should be pointed out that straightforward detailed analysis of muscular fatigue and its interrelated components or boundaries, namely initial and steady-state strengths, fatigable strength, and drop-off rate or decrement, is possible when one uses a spring-loaded ergograph. Such an analysis would have been impossible had the traditional weight-loaded ergograph been used in the present study.

Summary and Conclusions

In order to test the hypothesis that the muscular fatigability of school children is independent of their age when considered in relation to the muscular strength of their age group, data were secured on 100 boys and 100 girls ranging in age from 8 to 17 years inclusive. Ten children of each sex were tested within each one-year age group.

Fatigue curves of the forearm muscles were obtained with a strength recording apparatus that was adjustable to the hand size and the height of the person tested. Maximal contractions were made at the rate of 30 per minute for seven minutes. The resulting records were measured at intervals of one-half minute. These data were used to construct graphs of the average strength at each measured point for 10 subgroups within each sex, one for each age year. Exponential fatigue curves were fitted to the subgroup graphs, yielding curve parameters for fatigable strength, steady-state (fatigue level), and the logarithmic rate of drop-off in strength, as well as initial strength. Statistical analysis of the resulting data has led to the following conclusions:

1. Both initial and steady-state forearm muscular strengths increase progressively from age 8 through age 17 in boys, but tend to level off in girls above age 13. At age 8, there is no sex difference.
2. Fatigable strength tends to increase linearly with age from 8 through 17 years. Boys and girls do not differ at age 8, but the rate of increase in fatigable strength is much less rapid in girls than it is in boys.
3. The logarithmic rate of drop-off in strength that results from fatigue is the same in boys and girls at age 8, but tends to increase with age in boys and decrease with age in girls.
4. In general, there are no sex differences in muscular fatigability, either absolute or relative, at age 8. As boys become older, they become stronger, but tend to fatigue to a greater extent and also somewhat more rapidly. In contrast, girls increase less in strength and in fatigability. Older girls tend to

fatigue less rapidly than younger girls. The explanation for this may be motivational-cultural rather than physiological; the strength of the initial contractions of older girls is probably less than their physiological maximum.

5. Younger children are no more fatigable than older children, if the amount of fatigue is considered in relation to strength capacity. Girls and boys do not differ to any important extent, when fatigability is considered in relation to initial strength.

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Performance as Affected by Incentive and Preliminary Warm-Up[1]

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Abstract

Forty-six male students, ages 18 to 22 years, were given a softball throw for distance without warming up and with a 5-minute related warm-up preceding throwing. The subjects were divided into two groups with the sequence of warm-up and no warm-up alternated on different days in order to reduce the possibility of practice effect, learning, or other unforeseen factors. Three throws for maximum distance were allowed for each testing period. In an attempt to rule out the possible psychological effects of not making a maximum throw without preliminary warm-up, the subject was given a monetary reward for each throw greater than his established average. A significant difference at the 1 percent level of probability was found between trials 1 and 3 when no warm-up preceded throwing. No significant difference was found between trials when throwing was preceded by a warm-up. Despite the significant increase in distance between trials 1 and 3 when no warm-up preceded throwing, subjects threw on the average 10.2 ± 1.65 feet farther when throws were preceded by a 5-minute related warm-up. This difference was significant at the 1 percent level of probability.

FOR MANY YEARS coaches and teachers of physical education have advocated that warm-up exercises before performance in sports and dance are essential to maximum performance and prevention of injury. The supposed benefits of warming up have been attributed to increased range of motion in the joints, increased circulation, decreased viscosity, increased body and muscle temperature, and neural facilitation. Recent research has thrown new light on some of these factors and consequently the values of warming up prior to activity are being questioned.

It is becoming apparent that there is no one answer to the question and that such factors as the type of activity, the nature of the warm-up, the extent and intensity of the warm-up, the physiological make-up of the individual, and attitudes toward warming up must all be considered. If the results of the research in our field seem to be in conflict at this time, it probably is due to the fact that each study has attacked the problem from a different point of view with different factors involved.

Related Literature

An early study by Asmussen and Bøje (1) showed that preliminary exercise, short wave diatherapy, and hot shower types of warm-up were beneficial for short sprint and endurance type rides on a bicycle ergometer. The work of Muido (14) is in agreement with those of Asmussen and Bøje. Three subjects improved their swimming performance as a result of ten minutes of jogging. An even greater increase was made after very

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[1]This study was supported in part by University of California Faculty Research Grant No. 138.

heavy preliminary workout on a bicycle ergometer. Hot showers and diatherapy improved performance somewhat, but cold showers had a detrimental effect. Schmid (18) found that both active and passive methods of warm-up were beneficial for swimming 50 meters, running 100 meters, and riding a bicycle.

Karpovich and Hale (10) found no significant differences in running times of the 400-yard run or a sprint-type ride on a bicycle ergometer when they were preceded by preliminary exercise, deep massage, or digital stroking. Mathews and Snyder (12) also found that warm-up did not significantly improve the running times in the 440-yard dash. Simonson, Teslenko, and Gorkin (19) found that preliminary exercise improved the running time of the 100-meter run by an average of 7 percent. Blank (3) also found a significant difference in improved running time of track and field athletes in favor of warming up, while Hipple (8) found that eighth-grade boys do not improve their running times with a preliminary warm-up run.

Pacheco (17) experimented with ten experienced subjects who made 90 vertical jumps preceded by isometric stretching exercises, isotonic work (running in place), or a combination (knee bends). Compared with no preliminary exercise, performance was significantly improved for each individual and by each of the three exercises. In a more recent study Pacheco (16) had 166 girls in junior high school perform the jump and reach test preceded by three minutes of vigorous running in place. Significant improvements were observed when the jump and reach was preceded by a warm-up. In a study involving college women, Skubic and Hodgkins (20) found no significant difference between warm-ups which were related to the activity and those which were unrelated. Also, in performances involving strength, accuracy, or speed there was no increase in scores when a light warm-up preceded the activity as compared to no warm-up at all. The warm-up periods were of 1-minute duration. Burke (4) also found that warm-up with weak intensity and those of nonspecific type were not effective in increasing strength scores. On the other hand, he found that optimal intensity and duration of warm-up enhanced strength scores. Other phases of his study did not support the theory that warm-up decreases the viscosity of muscle, tissue, or sinovial fluid nor did warm-up result in increased circulation, increased supply of oxygen, or increased dissociation of oxygen from hemoglobin and myoglobin.

College men were tested in the softball throw for distance by Michael, Skubic, and Rochelle (15). The conditions used were (a) no preliminary warm-up, (b) warm-ups related to the activity, and (c) warm-ups unrelated to the activity (calisthenics and jogging). They found significantly increased throwing distances following both unrelated and related warm-up conditions. Swegan, Yankosky, and Williams (21) have observed that repetitive movement used as a warm-up produces faster performance of that movement in the case of arm flexion. On the other hand, Lotter (11) found that warm-up did not influence speed in arm movements of 20 male college students.

In a study using warm-up procedures customarily employed by competitive swimmers (hot showers, massage, calisthenics, and swimming), De Vries (6) found that the total group of 13 swimmers showed significant improvement only following the swimming warm-up but were not affected by procedures involving hot showers, calisthentics, or massage. Breast strokers and dolphin swimmers had the most significant improvement following calisthenics while the free style swimmers showed a significant decrease in speed after calisthenics warm-up.

Five groups of subjects were tested by Thompson (22) to determine if warm-up affected speed and endurance in swimming, accuracy in basketball foul shooting, accuracy in bowling, speed and accuracy in typing, and strength of softball players. There was no improvement from informal warm-up immediately preceding testing in swimming, typing, or strength. Formal warm-up did improve group performance in speed and endurance in swimming, accuracy in basketball foul shooting, and accuracy in bowling.

Apparently no studies have been done to determine whether the differences found between warming-up and not warming-up might be attributed to the

fact that subjects do not attempt an all-out effort without a warm-up due to the fear of injury. The present study attempts to determine whether any differences occur between warm-up methods when a monetary reward is given in obtaining maximum throws when no warm-up precedes throwing.

Purpose

In a previous study in which college men performed an all-out softball throw for distance both with and without preliminary warm-ups, it was found that there was improved performance in favor of warming-up (15). The investigators felt that the difference in distance that the ball was thrown when no warm-ups were used as compared to the use of warm-ups might have been due to a lack of effort on the part of the subjects when they performed without a warm-up. In any study involving no preliminary warm-up before performance, there is a question of whether subjects really perform to their maximum or whether they hold back consciously or unconsciously due to many years of training in the value of warm-ups for the prevention of injury. It was felt that this factor might possibly account for the significant differences found between the no warm-up and the warm-up conditions. With this in mind, the present study attempts to elicit an all-out softball throw, when not preceded by a preliminary warm-up, by offering a monetary reward.

Procedure

Subjects. The subjects for this investigation included 46 male students in apparent good health enrolled in general activity classes of the Department of Physical and Health Education at the University of California, Santa Barbara. The ages ranged from 18 to 22 years. None of the subjects had participated in varsity baseball during his high school or college time, and therefore none of the participants would be classified as baseball athletes.

Warm-up Method. A warm-up related to the activity (throwing a baseball) was selected as the warm-up method, since it was shown in a previous study by the writers (15) to be less variable than an unrelated warm-up (calisthenics) and to have an equal effect upon throwing performance as compared to an unrelated warm-up. This method was a specific warm-up using the identical action of the test activity. The activity consisted of playing catch with a partner for 5 minutes—one minute at 25 feet, one minute at 50 feet, one minute at 75 feet, one minute at 100 feet, and one minute at the farthest distance the subject could throw. In the event a ball was missed, another was put into play immediately in order to prevent any loss of time.

The Test. The subjects were divided into two groups with the sequence of warm-up and no warm-up alternated on different days in order to reduce the possibility of practice effect, learning, or other unforeseen factors. Three throws for maximum distance were allowed for each testing period. The distance of the throws was measured to the nearest one-tenth of a foot.

Incentive. In an attempt to rule out the possible hesitation at making a maximum throw without preliminary warm-up, the subject was told that a monetary reward would be given for each throw greater than the norm estab-

lished for his weight, height, and body type. This norm was not made known to the subject. In addition, to motivate the individual further, the first throw was valued at twice the monetary amounts of either the second or third attempts. It was hoped that this would provide the necessary motivation for each person to perform to maximum capacity on each of the three throws.

Statistical comparisons were made of the difference among each of the three trials for the respective testing days (Tables 1 and 2). The mean difference between trials 1 and 2, 2 and 3, and 1 and 3, using related warm-up, ranged from 0.59 to 2.60 feet. The difference between these trials was not significant. When no warm-up preceded throwing, the mean difference of 4.41 feet between trials 1 and 3 was significant at the 1 percent level of probability. This indicates a possible warm-up effect occurring after only two throws.

Table 3 contains the results of the comparison between related warm-up and no warm-up. On separate days, the subjects threw for distance with no warm-up and with a 5-minute warm-up. The average of the three throws after related warm-up was 10.2 ± 1.65 feet farther than when no warm-up was taken. This difference in distance was found to be significant at the 1 percent level of probability.

TABLE 1.—COMPARISON OF MEANS BETWEEN TRIALS WITH NO WARM-UP

Trial	Mean (Feet)	Difference Between Means			
		Diff.	S.E. Diff.	t	P
I	179.3				
II	181.0	1.70	2.07	0.831	.50
II	181.00				
III	183.70	2.70	1.94	1.386	.20
I	179.3				
III	183.70	4.40	1.59	2.773	.01

TABLE 2.—COMPARISON OF MEANS BETWEEN TRIALS WITH WARM-UP

Trial	Mean (Feet)	Difference Between Means			
		Diff.	S.E. Diff.	t	P
I	190.00				
II	192.00	2.00	1.35	1.489	.20
II	192.00				
III	192.60	0.60	1.50	0.393	.70
I	190.00				
III	192.60	2.60	1.67	.1556	.20

TABLE 3.—COMPARISON OF MEANS (AVERAGE OF THREE TRIALS) BETWEEN WARM-UP AND NO WARM-UP CONDITIONS

Conditions	Mean (Feet)	Difference Between Means			
		Diff.	S.E. Diff.	t	P
Warm-up	191.50				
No warm-up	181.30	10.20	1.65	6.182	.001

Discussion

In this study, the psychological effects of throwing, when not preceded by a warm-up period, were suppressed to an appreciable extent by the incentive of a monetary reward. It is, however, almost next to impossible to rule out completely the mental phenomenon attached to warm-up. The beneficial effects of strenuous warm-up are borne out in this study. In addition, when a monetary incentive was given for particular distances thrown, a significant difference at the 1 percent level of probability was obtained between the first and third throws when no warm-up preceded throwing. This indicates that there is a beneficial warm-up effect produced in a short period of time, but under maximum exertion. This particular phenomenon did not occur when a related warm-up preceded throwing. Despite the significant increase in distance between the first and third throws when throwing without a preliminary warm-up, a very significant difference was found ($t = 6.182$)[2] between the two methods in favor of warming up.

The exact reasons for this increase in performance are not entirely clear. It may be that (a) when there is a sudden stretch, as in a maximum distance throw, performance is improved by elevating muscle and body temperature; (b) when a muscle is warmed, the speed with which the muscle contracts and the force of contraction are increased; and (c) when there is an increase in body performance, there is greater speed of reaction of the chemical and physiological processes involved in muscular contraction. Even though the causes are not definitely known, a beneficial warm-up effect does occur under certain conditions.

Conclusions

Within the limits of this study the following results appear justified:

1. A significant difference at the 1 percent level of probability was found between trials 1 and 3 when no warm-up preceded throwing. This indicates that a monetary reward was beneficial in obtaining a maximum throw for distance and, under such conditions, a beneficial warm-up effect after only two throws.

2. No significant difference was found between trials when throwing was preceded by a related 5-minute warm-up.

3. Despite the significant increase in distance between trials 1 and 3 when no warm-up preceded throwing, subjects threw farther when throws were preceded by a related warm-up. This difference was significant at the 1 percent level of probability.

4. The distance associated with related warm-up was 10.2 ± 1.65 feet farther than with no warm-up.

5. No report of muscle soreness was obtained, regardless of whether or not warm-up preceded throwing.

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[2]Significant at the 1 percent level of probability.

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(Submitted 1/4/60)

Maximal Work Capacity of Human Intact Muscle under Hyperaemic Conditions[1]

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Abstract

Fatigue curves for the forearm muscles, doing maximal static and dynamic work, were obtained under control conditions and under conditions of hyperaemia. The hyperaemia was evoked by subjecting the muscles of the forearm for a specific length of time to circulatory occlusion with a blood pressure cuff and then suddenly releasing the cuff pressure. The maximal increase in forearm volume, resulting from the postocclusion hyperaemia, followed a mathematical curve when it was expressed as a function of the occlusion time. A significant decrement in work capacity was found immediately aftei ten minutes of occlusion. This short-time negative influence did not affect the total output.

THE CAPACITY OF muscle to continue work at a given workload is determined by a number of factors. Müller (2, 4) contends that an increase in workload produces an increase in blood supply during activity, partly because of a regulatory dilation of the blood vessels and partly as a result of the pumping action of the working muscles. He has conducted a series of experiments, which involved the cooling of the working limb. His results showed that work capacity was reduced during reactive hyperaemia. It was concluded that this was due to the cooled skin which increased its circulation at the cost of the muscle circulation.

Nukada (3) followed with a study in which hyperaemia of the working limb was brought about by the sudden release of a previously administered circulatory occlusion. He tested two 41-year old men on a calf muscle ergometer (resembling the old-fashioned sewing machine) under four conditions —no preliminary occlusion of the circulation, compared with 2 min., 5 min., and 10 min. of occlusion by a pressure cuff around the thigh. The pressure was released and the work was started after an interval of 0.5, 2 and 5 min. The workload was constant at 495 kgM/min. for the first subject and 375 kgM/min. for the second subject, the rate of movement being 60 cycles per minute. As a result he found that when the work was started with the least amount of delay after release of the occlusion, the subject was able to perform longer. He also reported that the longer the occlusion lasted, the longer the subject was able to keep the workload at the predetermined level. He concluded that work capacity of the muscle group was increased from two- to three-fold with the longest duration of previous occlusion. He contended that the occlusion type of reactive hyperaemia affected mainly the blood supply

[1] From the Research Laboratories of the Department of Physical Education.

to the working muscle, whereas hyperaemia due to cooling as in Müller's experiments affected mainly the blood content of the skin.

Although it was implied that an improved circulation was the cause of the greater work capacity, no statistical treatment of this assumption was possible, since data in regard to the actual volume changes of the lower leg during hyperaemia were lacking. Nor was any mention made of an experimental design that would balance out learning, or training, from one test period to the next. Moreover, fixing the workload at a certain level (not maximal at all times) gives a very restricted picture of the mechanisms involved. Only one factor could be analyzed for changes, namely, the length of time that this work could be kept up. Last but not least, the number of subjects (N = 2) was too small to make statistically valid conclusions.

A study of the effect of reactive hyperaemia on work capacity of the muscle should give consideration to the length of time of the preliminary occlusion, the variation in limb volume, and changes in static as well as dynamic fatigue curves resulting from hyperaemia.

Apparatus and Method

A recording spring-loaded ergograph designed by Henry[2] was used to obtain muscle fatigue records under static as well as dynamic conditions, as

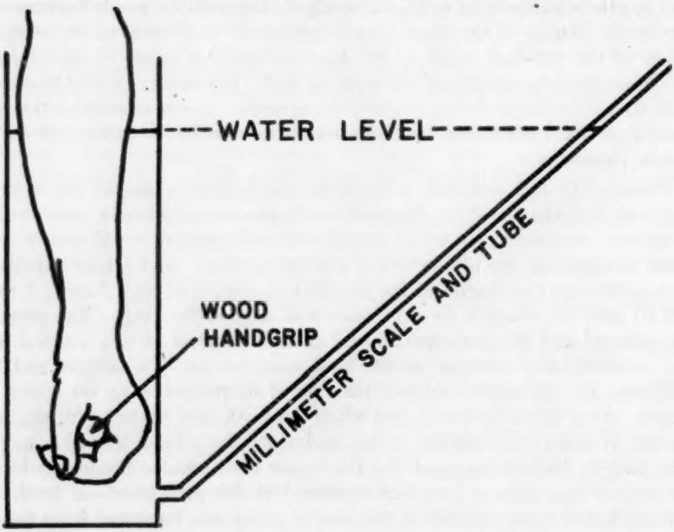

FIGURE I. Plethysmograph for measuring arm volume.

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[2] This instrument was first used by Grose (1). Subsequently it has been modified by mounting the apparatus in gimbals and attaching the dynamometer to the paper drive unit with a semi-flexible support. This makes the base line more stable than before.

explained below. Reactive hyperaemia in the forearm was produced as a reaction following the release of circulatory occlusion caused by a blood pressure cuff inflated to 220 mm.Hg.

The subject stood with his forearm immersed in the water (30-32°C) in a plethysmograph tank. A sensitive water level gauge, calibrated in units of plethysmograph volume, measured the forearm volume changes by the water displacement method (Figure I). The occlusion cuff was placed on the upper arm and inflated. A reading of the plethysmograph was taken at the end of the standard duration of occlusion, immediately before the cuff was suddenly deflated. A second reading was taken when the postocclusion swelling (reactive hyperaemia after release of the cuff pressure) had reached its maximum. This occurred within the range of 7 to 15 sec. after deflation. The subject then withdrew his arm from the water, quickly dried his hand and fingers (within 45 sec.), and started the work on the ergograph.

The first work experiment required the subjects (N = 22) to hold a maximal static (isometric) contraction for 2 min. on the ergograph. In this experiment all subjects were tested under four conditions, control and following occlusion durations of 2, 5, and 10 min. A new series of subjects (N = 23) was used in a second experiment (dynamic work) in which repeated maximal contractions were made on the ergograph at the rate of 30 per minute. In this case, the contractions were not held; each was only of momentary duration. This work was continued for 210 contractions. Tests were made under control conditions and after a 10-min. occlusion. (The results of the first experiment had established that maximal hyperaemia was produced by this length of occlusion, as shown by the insert graph of Figure II).

In both experiments the subjects were male students in physical activity classes (age 18-28 and 18-26 in the first and second experiment, respectively). Only one condition was measured at a test period; there was an interval of one week between measurements. Testing was done on a rotating basis so as to balance any training effect. No retests were given for any of the conditions.

Results

Postocclusion Hyperaemia. This was studied only in the first experimental group (N = 22). The forearm volume averaged 905 cc. under conditions of circulatory occlusion. When the occlusion was released, the forearm volume quickly increased (within 1/4 min.) to some maximal value depending on the length of the occlusion. A variance analysis of these maximal values as a function of the duration of occlusion shows that the length of occlusion has a highly significant influence (Table 1). It may be noted that this analysis also reveals that there are significant individual differences in the hyperaemic response, since the F-ratio for subjects is 4.837.

The influence of occlusion duration on the amount of hyperaemia obeys a law of diminishing return, as shown by the insert graph of Figure II. This relationship is exponential, of the form

$$y = c - a_0 e^{-kt}$$

where y is the volume of the arm, c is the maximal possible volume or asymp-

totic level, a_o is the amount of swelling possible (the difference between the preocclusion arm volume and the asymptotic level), k is the experimental rate constant, t is elapsed time after the start of the occlusion, and e is the usual Napierian log base. In this experiment, $c = 930$ cc, $a_0 = 25$ cc, and $k = 0.4578$. The smooth curve in the insert graph was computed from this formula; it will be noted that it fits the experimentally determined points very closely.

Individual differences in the amount of increase in forearm volume resulting from 10 min. of occlusion are not significantly related to the initial forearm volume ($r = -.143$). On the other hand, the correlations between the amounts of hyperaemia caused by different durations of occlusions are fairly high. Between 2 and 5 min. the correlation is .735, between 5 and 10 min. it is .707. It is considerably lower between the 2 and 10 min. conditions, namely .404. It must be remembered that these different durations were used on different days.

Static Work. The smooth curve labeled static in Figure II is drawn through the average of the data, including both experimental and control conditions.

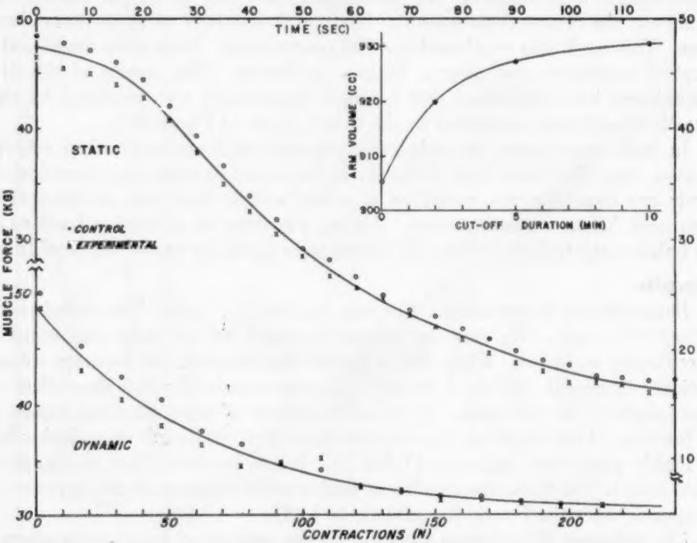

FIGURE II. Fatigue curves for static and dynamic contractions. The insert graph shows the development of reactive hyperaemia (arm volume) as a function of the length of time that the circulation was occluded. The upper left fatigue curve shows the dropping off in muscle force under the static condition. The curve just below it shows the diminishing muscle force under the dynamic condition.

TABLE 1.—VARIANCE ANALYSIS OF THE EFFECT OF OCCLUSION ON INCREASE OF FOREARM VOLUME

Source of Variance	d.f.	MS	F
Total	65	.1879	—
Subjects	21	.3807	4.837[a]
Conditions (2, 5, 10 min. occlusion)	2	.4570	5.806[a]
Error	42	.0787	—

[a] Statistically significant (5% level).

TABLE 2.—VARIANCE ANALYSIS OF THE EFFECT OF OCCLUSION TIME ON ISOMETRIC WORK CAPACITY

Source of Variance	First Minute of Contraction			Second Minute of Contraction	
	d.f.	MS	F	MS	F
Total	87	2618.9298	—	1262.8778	—
Subjects	21	9350.4832	22.11[a]	3541.1366	6.53[a]
Conditions (0, 2, 5, 10 min. occlusion)	3	1613.4959	3.81[a]	439.0000	.81
Error	63	422.9407	—	542.6825	—

[a] Statistically significant (5% level).

The mean scores for the most extreme experimental condition (10-min. occlusion) are shown as a function of time in this figure, and may thus be compared with the mean scores for the control conditions which are also shown. It may be seen that this experimental condition results in a lowering of the muscle force by a considerable amount in the early part of the fatigue curve, and this continues to a lesser extent throughout the work period. (The results for lesser durations of occlusion, namely 2 and 5 min., fall between the experimental and control results that were plotted.)

The difference for the initial strength (the first point on the curve) is statistically significant at the 5 percent level ($t = 2.49$). When the first half of the work period is examined (first 12 points, Table 2) by means of analysis of variance, it is found that there is a significant variation between the four conditions ($F = 3.81$). Less work, rather than more, is produced under the condition of reactive hyperaemia (differences with the control after 5 and 10 min. of occlusion: $t = 2.53$ and 3.17, respectively). Examination of the last half of the work period (12 points) fails to show any significant variation between the four conditions ($F = .81$).

Dynamic Work. Figure II also shows the mean values for dynamic work at intervals of 15 contractions (30 sec.). Again the initial strength is higher for the control condition than after a circulatory occlusion. This difference is statistically significant ($t = 2.77$). Reactive hyperaemia increases the amount of fatigue ($t = 2.74$), but has no effect on the residual amount of strength after fatigue ($t = .18$). The total amounts of work produced (sum

of 15 points on the curve) do not differ significantly ($t = 1.65$). When the work produced during the first half of the curve is examined, it is found that there is a significant difference between the two conditions ($t = 3.76$). Less work is produced during this time under hyperaemic conditions. Examination of the work done during the last half of the work period shows no significant difference between the two conditions ($t = .24$).

Discussion

Reactive hyperaemia significantly lowers the initial strength, under either static or dynamic conditions. Nukada's (3) contention that hyperaemia increases work capacity is not borne out by these results, since the amount of work was decreased rather than increased under hyperaemic conditions. This decrease occurred chiefly in the first half of the curve and was statistically significant. No significant change in work output was observed in the second half. It was also found that there was no difference in the error variance in this half, as compared to the first half ($F = 1.28$, with df 63). Cursory visual inspection of the records suggested that possibly the subjects performed more erratically during the later stages of fatigue.

In explanation of the above results, it may be hypothesized that acid metabolites, resulting from the circulatory occlusion, not only evoke the hyperaemia but also have a detrimental influence on maximal work output. The concentration of these "occlusion acid metabolites" can be visualized as gradually diminishing to zero with the passage of time after the occlusion as a result of the restored circulation. The "work acid metabolites," or fatigue products, start to accumulate at the beginning of work and are increasing in concentration during the ensuing work period until the steady state, or fatigue level, is reached. The "occlusion acid metabolites" have probably disappeared by this time, although they would still be present and have a detrimental effect during the first part of the work period. Near the end of the work period, as the fatigue level is approached, there would be essentially the same concentration of fatigue products, whether hyperaemia occurred prior to the start of the work or not.

The latter explanation would mean that a longer interval between release of the occlusion and the start of the work would be less harmful to the work capacity, since the circulation would have more time to reduce the local (prework) concentration of acid metabolites. This seems to be contrary to Nukada's findings, which show a better performance with the shortest interval between release of occlusion and the start of work.

Nukada did not report any experimental evidence in support of his suggestion that a longer occlusion time evokes a greater hyperaemia. The present study shows that it does, although not without limit. It seems that eventually a maximal level of hyperaemia will be reached regardless of a further increase in occlusion time. The mathematical equation which represents the increase in forearm volume shows that this level will be approached after a previous circulatory occlusion of approximately 10 min.

Summary and Conclusions

Fatigue curves for intact human muscle under maximal static and dynamic performances were studied with regard to the effect that reactive hyperaemia, as evoked by preliminary occlusion of the circulation, has on work capacity. In the first series (static work) 22 young men were tested in a balanced series four times on a spring-loaded recording hand-dynamometer, once with normal circulation and three times during hyperaemia. The reactive hyperaemia was evoked by the release of a pressure cuff around the upper arm, which occluded the circulation for 2, 5, and 10 min. The hyperaemic forearm volume increase was measured by a plethysmograph.

In a second series (dynamic work) 23 young men performed in a balanced series under two conditions, once with normal circulation and once after a 10-in. preliminary occlusion.

Although forearm volumes showed significant *increments* during reactive hyperaemia, the initial strength and work output during the first half of either the static or dynamic performance showed significant *decrements.* This suggests the presence of occlusion-produced metabolites which have a detrimental effect on the performance. Except for the latter, short-time negative influence, the occlusion-type of reactive hyperaemia does not affect muscular work capacity.

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(Submitted 7/22/59)

Health Needs and Interests as a Basis for Selecting Health Content in Secondary Schools[1]

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Abstract

A valid and reliable inventory was developed for measuring the health needs and interests of secondary school students. Four adaptations to the inventory were administered to students, parents, health teachers, and physicians. Results indicate a common core of health interests among high school students. Health needs as expressed by high school girls and boys are markedly different. The parents, health educators, and medical doctors were in agreement on the basic health needs of the high school student. The adult and student portions of this sample were in some disagreement on what the high school child needs to learn about health.

THE PROBLEM OF this study was to determine and analyze the health needs and interests of selected secondary school students in Indiana. Although there were several purposes, the primary purpose was to provide a valid and reliable inventory for determining the health needs and interests of secondary school students. This inventory could be used by health teachers and health coordinators in planning classes or programs of health education.

Review of Related Studies

A review of the literature revealed a number of studies that have been done in order to determine the health interests of various grade level groups. Several studies indicated that an attempt was made to discover both needs and interests, but actually the respondents were indicating only their interests.

Studies by Raths and Metcalf (11), Turner (13), and the Denver Study (2) dealt with health interests at the elementary level. The investigations by Hayes (3), Lerrigo (6), Lantagne (4), and the Denver Study (2) were concerned with health interests at the high school level. The studies by Malfetti (8), Rooks (12), Lantagne (5), Osburn and Murphy (10), Oberteuffer (9), and Whiteley (14) dealt with health interests at the college level.

The studies made by Malfetti (8), Hayes (3), and Oberteuffer (9) utilized the method of asking the student to write down either problems, interests, questions, or situations which were of concern to the student.

The most frequently used method was to develop either a check list or a questionnaire and administer it to the people involved. Raths and Metcalf (11), the Denver Study (2), Rooks (12), Lantagne (4, 5), Osburn and Murphy (10), and Whiteley (14) utilized this method.

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[1]This study was made in partial fulfillment of the requirements for the degree of Doctor of Health and Safety in the School of Health, Physical Education, and Recreation, Indiana University, Bloomington, Indiana, September 1959.

Many of the instruments devised in these studies used terminology which could very possibly be above the comprehension ability of some of the respondents. None of the previous studies reported having consulted with the medical doctors to get their opinion on the health needs of high school students.

Therefore, the literature revealed numerous studies that have been aimed, primarily, at the health interests of children. There has not been a study to determine both the specific needs and interests of school children at the same time by consulting with students, parents, health educators, and physicians.

Procedures

It was decided that all available tenth grade students who attended a high school in Monroe County, Indiana, would make up the student portion of the sample. In Indiana, the largest percentage of high schools meet the health course requirement in the tenth grade (7). A random sample of 100 parents (50 mothers and 50 fathers) of these same tenth grade students were interviewed. In addition, all available health educators and medical doctors (general practitioners) were contacted.

It was felt that by contacting all of these groups a truer description of the health needs and interests of high school students could be obtained. Therefore, it was necessary to select and organize health content, of accepted importance, that could be utilized in having these four groups express their feelings and/or opinions.

The writer made the assumption that teachers tend to teach from the textbook that their school has purchased, start on page one, and go as far as they are able to in the allotted time. Of course, this assumption is not always true. However, if this assumption is true, the content of the inventory should be based on health textbooks currently in use.

Curricular validity was established as a result of the evaluation of nine high school health textbooks and through consultations with experts in the field of health. The topics found in the texts were transferred into meaningful statements that the student and parent could understand. It was felt unnecessary to interpret the concepts to the health educator and physician.

The inventories were prepared so that the student, parent, health educator, and medical doctor indicated a degree of need and/or interest in the statements on a 10-point equal appearing interval scale. The scale ranged from zero to nine with zero meaning little or no need and/or interest, and nine meaning high or great need and/or interest in the statements. An information and direction sheet was constructed for each of the different kinds of respondents according to the needs and purposes of this study.

The final inventories consisted of 10 health areas with 207 health concept statements. The first inventory was prepared, with the 207 interpreted subtopics, for students to indicate their degree of interest in each of the statements. The second inventory was prepared, with identical statements, for students to indicate their degree of need to learn about each of the statements. The third inventory was prepared, with identical statements except that the first person was omitted, for parents to indicate the degree to which they feel their high school sophomore son or daughter needs to learn

about each of the statements. The fourth inventory was prepared, with the original subtopic items, for health educators and medical doctors to indicate the degree to which they feel high school students need to learn about each of the statements.

These inventories were then administered to 501 students, who responded both on their needs and interests, 100 parents, 20 health educators, and 17 medical doctors.

An attempt was made to determine the accuracy with which the instrument used in this study measured student needs and interests. The test-retest method for estimating reliability was used in this study. The health needs inventory was administered to 40 students and the health-interests inventory to 41 students within a period of not less than two weeks and no more than three weeks from the first administration. A rank difference correlation coefficient was computed between the first and second administrations on both the needs and interests inventories. A reliability coefficient of .82 was obtained on the needs inventory. A reliability coefficient of .90 was obtained on the interests inventory. These data seem to indicate a high reliability on both the health needs and health interests inventories.

The data were organized and analyzed to determine a rank order of health needs and interests, both for areas and specific concepts, for the various groups in the sample. Rank difference correlation coefficients were computed to determine the degree of agreement between the various groups.

In an attempt to provide additional information, along with rank order, as to the degree of need and/or interest, a percentage of emphasis was established for each health statement as well as health area. The percentage of emphasis appears to be a more meaningful indication of the degree to which the respondents expressed a need or interest.

Results

The data in Tables 1 and 2 reveal the rank order of the ten health areas and the percentage of emphasis of felt needs and interests as expressed by students. Students expressed highest felt need in the area of understanding mental health and mental illness and the lowest in structure and function of the human body. The specific items they felt the greatest need to learn about were again in the area of mental health. The items they felt the least need to learn about were in the areas of structure and function of the human body and community health services and facilities.

The students expressed the highest interest in the area of understanding mental health and mental illness and the lowest in the area of food needs of the body. The specific items of highest interest to the students were in the area of mental health and personal care of the body. They were least interested in the items for the areas of structure and function of the human body and community health services and facilities.

In general, the students expressed a need to learn about the functional or practical aspects of health. They indicated the highest interest in subject

TABLE 1.—RANK ORDER OF THE TEN HEALTH AREAS OF FELT NEED AS EXPRESSED BY 501 STUDENTS

Rank Order	Health Area	% of Emphasis
1	Understanding Mental Health and Mental Illness	67.49
2	The Importance of Activity and Rest	62.20
3	Personal Care of the Body	61.81
4	Understanding Harmful Habit-Forming Substances	61.76
5	Medical Advances for Health	58.92
6	Food Needs of the Body	58.71
7	Official and Voluntary Public Health Programs	58.54
8	Interpretation of Health[a]	58.18
9	Community Health Services and Facilities	57.08
10	Structure and Function of the Human Body	55.33

[a] Interpretation of Health includes such things as the meaning of health, health protection, life expectancy, and mortality rates.

TABLE 2.—RANK ORDER OF THE TEN HEALTH AREAS OF FELT INTEREST AS EXPRESSED BY 501 STUDENTS

Rank Order	Health Area	% of Emphasis
1	Understanding Mental Health and Mental Illness	68.51
2	Personal Care of the Body	66.70
3	The Importance of Activity and Rest	63.87
4	Interpretation of Health	61.97
5	Understanding Harmful Habit-Forming Substances	60.79
6	Medical Advances for Health	55.46
7	Official and Voluntary Public Health Programs	53.95
8	Community Health Services and Facilities	53.60
9	Structure and Function of the Human Body	51.87
10	Food Needs of the Body	50.99

matter which deals with physical and emotional development. Although their needs and interests appear to be somewhat similar, a closer examination reveals that the students did discriminate between needs and interests. This is especially true on the specific health concepts.

The data in Tables 3, 4, and 5 show the rank order of the ten health areas and the percentage of emphasis of student needs as expressed by parents, health educators, and medical doctors.

The parents gave the highest emphasis to the area of understanding mental health and mental illness and the lowest to medical advances for health. The specific concepts they felt their high school children need to learn about were in subject matter involving mental health, narcotics, and personal cleanliness. The concepts given the least emphasis were in subject matter involving the nervous system, digestive process, and available health services and facilities.

The health educators gave the highest emphasis to the area of understanding mental health and mental illness and the least emphasis to medical advances for health. In regard to specific concepts, the subject matter about

mental health, narcotics, and personal cleanliness were given the highest emphasis. Those concepts receiving little emphasis dealt with subject matter about the nervous system, anatomy, medical advances, and available health services and facilities.

TABLE 3.—RANK ORDER OF THE TEN HEALTH AREAS OF STUDENT NEEDS AS EXPRESSED BY 100 PARENTS

Rank Order	Health Area	% of Emphasis
1	Understanding Mental Health and Mental Illness	75.41
2	Understanding Harmful Habit-Forming Substances	74.53
3	Food Needs of the Body	72.72
4	Personal Care of the Body	70.93
5	Interpretation of Health	70.75
6	The Importance of Activity and Rest	68.60
7	Official and Voluntary Public Health Programs	65.85
8	Community Health Services and Facilities	64.59
9	Structure and Function of the Human Body	57.16
10	Medical Advances for Health	54.61

TABLE 4.—RANK ORDER OF THE TEN HEALTH AREAS OF STUDENT NEEDS AS EXPRESSED BY 20 HEALTH EDUCATORS

Rank Order	Health Area	% of Emphasis
1	Understanding Mental Health and Mental Illness	78.05
2	Understanding Harmful Habit-Forming Substances	76.22
3	Personal Care of the Body	74.81
4	Food Needs of the Body	71.42
5	The Importance of Activity and Rest	70.33
6	Structure and Function of the Human Body	66.89
7	Interpretation of Health	63.89
8	Community Health Services and Facilities	62.81
9	Official and Voluntary Public Health Programs	60.83
10	Medical Advances for Health	53.94

TABLE 5.—RANK ORDER OF THE TEN HEALTH AREAS OF STUDENT NEEDS AS EXPRESSED BY 17 MEDICAL DOCTORS

Rank Order	Health Area	% of Emphasis
1	Personal Care of the Body	64.01
2	Understanding Mental Health and Mental Illness	63.56
3	Understanding Harmful Habit-Forming Substances	63.52
4	Community Health Services and Facilities	60.28
5	Interpretation of Health	59.97
6	The Importance of Activity and Rest	59.28
7	Food Needs of the Body	53.39
8	Official and Voluntary Public Health Programs	47.53
9	Structure and Function of the Human Body	46.14
10	Medical Advances for Health	35.41

The medical doctors gave the most emphasis to personal care of the body, although the areas of understanding mental health and mental illness and understanding harmful habit-forming substances were ranked a very close second and third. The area given the least emphasis was medical advances for health. The strongest emphasis in the specific concepts dealt with subject matter about mental health, narcotics, personal cleanliness, and the proper use of available health services. The concepts receiving the least emphasis were about subject matter including anatomy and physiology, medical advances, and public health programs.

A close examination of the areas and specific concepts revealed that the student needs as expressed by these three groups are similar. The areas and items for understanding mental health and mental illness, personal care of the body, and understanding harmful habit-forming substances were given the most emphasis by all three groups. All three groups gave the least emphasis to medical advances for health. In general, all the groups indicated that high school children have the greatest need to learn about those things dealing with caring for one's self and being able to cope with life's situations.

It should be noted that the ranges between the areas given the most and least emphasis, by the student and adult groups, demonstrated their ability to discriminate between the areas. The two groups had definite feelings and/or opinions on the subject matter which needs to be stressed in the high school health course. This was more clearly demonstrated in the specific health concepts, where the ranges were markedly wide. In addition, there was common agreement, among all the groups, on those areas given the highest emphasis.

Table 6 lists some of the significant rank order correlations of felt needs and/or interests on the ten health areas between various student and adult

TABLE 6.—RANK ORDER CORRELATIONS OF FELT NEEDS AND/OR INTERESTS BETWEEN VARIOUS STUDENT AND ADULT GROUPS

Group 1	Group 2	Correlation
Student Needs	Student Interests	.77
Girls' Needs	Boys' Needs	.56
Girls' Interests	Boys' Interests	.82
Urban Student Needs	Rural Student Needs	.31
Urban Student Interests	Rural Student Interests	.83
Urban Girls' Needs	Rural Girls' Needs	.94
Urban Girls' Interests	Rural Girls' Interests	.96
Urban Boys' Needs	Rural Boys' Needs	.13
Urban Boys' Interests	Rural Boys' Interests	.80
Student Needs	Parents' Needs	.60
Student Needs	Health Educators' Needs	.61
Student Needs	Medical Doctors' Needs	.49
Mothers' Needs	Fathers' Needs	.89
Parents' Needs	Health Educators' Needs	.88
Parents' Needs	Medical Doctors' Needs	.73
Health Educators' Needs	Medical Doctors' Needs	.72

groups. The rank order correlation coefficients ranged from .13 to .96. Therefore, the range between the lowest and highest relationship was .83. This clearly indicated that the degree of agreement between various groups differs to a great extent.

There was a relatively high relationship between felt needs and interests as expressed by the students with good agreement in all areas except food needs of the body. A breakdown within the student sample reveals that, regardless of the type of breakdown, students have a common core of interests but their felt needs vary to a great extent. The one exception was that the degree of agreement between girls on their felt needs and interests was extremely high. In general, there were marked differences between girls and boys on what they feel they need to learn. This may support the separation of the sexes for the health class. In addition, there were marked differences between urban and rural students on what they feel they need to learn, especially the boys. It should be noted that, throughout the comparisons of the student portion of the sample, the boys indicated a high need to learn about the area of food needs of the body. In contrast, the girls expressed an extremely low need to learn about this area.

There was a relatively low relationship between students and adults on what they feel the high school students need to learn about health. Although this disagreement was present, there was high agreement in some of the areas. There was high agreement among the adult groups on what they feel high school students need to learn. The highest agreement, among the adult groups, was between mothers and fathers, and parents and health educators.

An analysis between students and parents reveals that boys tend to agree with their mothers and fathers much more than girls do on their health needs. The students consistently expressed a fairly high need to learn about the area of medical advances for health while the adult groups gave this area the least emphasis. It was interesting to note that the medical doctors were the only group to indicate a high need for students to learn about community health services and facilities. In addition, the health educators and medical doctors indicated little need for students to learn about official and voluntary health programs.

The four groups involved in this study gave the most emphasis and had the highest agreement in the areas of understanding mental health and mental illness, personal care of the body, understanding harmful habit-forming substances, and the importance of activity and rest. It was also agreed that the areas of structure and function of the human body, community health services and facilities, and official and voluntary health programs be given the least emphasis. An analysis of the specific health concepts seemed to bear out the above statements.

The data in Tables 7 and 8 show the rank order of those specific health concepts that students and adults agree upon as being of the most and least importance to be included in the high school health course. The health concept that students and adults agree upon as being of most importance to be

TABLE 7.—A RANK ORDER OF THE 40 HEALTH CONCEPTS AGREED UPON AS BEING MOST IMPORTANT BY 501 STUDENTS AND 137 ADULTS

Rank order	Health Concept	Average rank
1	The importance of personal appearance.	7.88
2	The ways to get along with other people.	9.13
3	The development of a feeling of confidence and self-respect.	9.88
4	The way to determine, react to, and solve problems.	10.00
5	The importance of knowing what is right, and what is wrong.	11.63
6	The reasons why and how a person should keep his skin clean.	15.88
7	The reasons why and how a person should keep his face, hair, hands, and nails clean.	17.38
8	The ways a person can prevent poor health.	17.75
9	The way in which courage, truthfulness, and honor are developed.	18.38
10	The way to plan for the future.	19.38
11	The control of diseases which spread from one person to another.	20.25
12	The reasons why and how a person should keep his teeth clean.	21.00
13	The importance of developing good habits.	22.25
14	The way narcotics affect the body.	22.50
15	The reasons why it is important for a person to have good mental health.	24.50
16	The way alcohol affects the body.	25.50
17	The safeguards that make possible good water, food, milk, and housing in the community.	25.63
18	The importance of success and failure.	26.50
19	Those things that make a person mentally healthy.	26.88
20	The importance of standing and sitting properly.	27.13
21	The way tobacco and smoking affects the body.	28.13
22	The ways to avoid worry and nervousness.	30.30
23	The meaning of love.	31.25
24	The ways a person can avoid becoming mentally ill.	32.25
25	The things which are in habit-forming narcotics.	32.50
27	The effect of feelings on health.	32.75
27	The ways to control a person's temper.	32.75
27	The things a person should know about narcotics.	32.75
29	The way attitudes affect the way people behave.	33.50
30	The importance of getting plenty of sleep and rest.	34.13
31	The reasons why people behave the way they do.	34.88
32	The reasons why people should train their feelings.	35.75
33	The things a person should know about gaining weight and losing weight.	37.38
34	The influence of fear and hate upon health.	37.50
35	How much a person should weigh.	42.00
36	The kinds and types of narcotics.	42.50
37	The way physical exercise affects the body.	43.00
38	The reasons why a person becomes mentally ill.	44.63
39	The need of having spare time activities.	47.63
40	How a person should choose a doctor.	54.00

TABLE 8.—A RANK ORDER OF THE 23 HEALTH CONCEPTS AGREED UPON AS BEING LEAST IMPORTANT BY 501 STUDENTS AND 137 ADULTS

Rank order	Health Concept	Average rank
1	The names of the different muscles in the body.	202.63
2	The instruments used by doctors.	193.50
3	The advantages of a group of doctors who give medical service in a clinic.	192.63
4	The way to get rid of unwanted hair on the legs, arms, or armpits.	189.38
5	The tube that takes the air from the throat to the lungs.	184.63
6	The nerve message that requires a mechanical or chemical stimulus.	182.14
7	The types of nerves which carry messages to and from cells in the body.	180.55
8	How long a person can expect to live.	178.25
9	The place where tests are made to determine types of diseases.	176.63
10	Those parts of the body which enable oxygen to pass into the blood.	175.00
11	The tube through which food passes from the throat to the stomach.	174.88
12	The skin gland that removes the excess salt in the body through sweat.	169.75
13	That part of the body which stores blood until it is needed.	169.38
14	The way the nose and throat helps a person to take in air.	168.50
15	The kinds of muscles that are found in the heart.	167.88
16	The different bones which are located in the head, chest, arms, trunk, and legs.	166.75
17	The health discoveries and the people who have made better health possible through their studies.	165.25
18	The work being done by the agency that coordinates all health efforts in the community.	164.75
19	The functions of the outer layer of cells within the brain.	163.63
20	The nerves which slow down the heart beat and help in digestion.	163.25
21	The health services offered to aged people.	162.13
22	The activities inside the body over which a person has little or no control.	156.50
23	The functions of the outer and inner layers of skin on the body.	155.75

included in the health course was "the importance of personal appearance." Four other concepts which seem to stand out were "the ways to get along with other people," "the development of a feeling of confidence and self-respect," "the way to determine, react to, and solve problems," and "the importance of knowing what is right and what is wrong."

The area of understanding mental health and mental illness received the most emphasis with more than one half of the items in the top 40 health concepts given to this area. Other areas given high emphasis were personal care of the body and understanding harmful habit-forming substances. It should be noted that they did agree on two concepts dealing with official and voluntary health programs. These concepts were "the control of diseases which

spread from one person to another" and "the safeguards that make possible good water, food, milk, and housing in the community." The students and adults, in general, seemed to agree on those items dealing with caring for one's self and being able to cope with life's everday situations and experiences.

The health concept that students and adults agree upon as being of least importance to be included in the health course was "the names of the different muscles in the body." Two other concepts which seem to stand out as being of little importance were "the instruments used by doctors" and "the advantages of a group of doctors who give medical services in a clinic."

Health concepts for the area of structure and function of the human body were given the least emphasis with approximately two thirds of the items in the bottom 23 being devoted to this area. The above mentioned area was the only area that stood out predominantly as being of lesser importance in the health course. The students and adults, in general, seemed to agree that those items dealing with structure and function of the human body were of lesser importance to the high school student.

Conclusions

On the basis of the inventory and sampling used in this study, the following conclusions are made:

1. There is a common core of interest among high school students regardless of the categories into which the students were placed.

2. The expressed needs of girls and boys are markedly different, which may support the separation of the sexes in the health class.

3. The areas of understanding mental health and mental illness, personal care of the body, understanding harmful habit-forming substances, and the importance of activity and rest appear to be the most important areas for inclusion in a high school health course.

4. The areas of structure and function of the human body, community health services and facilities, and official and voluntary health programs appear to be the least desirable for inclusion in a high school health course.

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Frequency Distributions and Standards of Anthropometric and Physical Performance Measures for College Women

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Abstract

Frequency distributions of the records of a random selection of 200 college women in a nonmajor required program on anthropometric and physical performance measures commonly employed in physical education were compared with best-fitting normal curves for the same data. A table of random numbers was used to secure the sample. A percentile table for the various measurements was constructed. It was concluded that various measurements commonly employed by physical educators give a non-normal distribution. Hence, the obtained distribution as found on various measurements in this study does not warrant treating these data as normal.

NUMEROUS PHYSICAL performance and anthropometric measures have been developed and recommended for use with college women. These measurements presumably measure many different aspects of the individual's physical make-up. There are tests to measure agility, power, motor ability, balance, and physical fitness. Among persons interested in the various aspects of physical measurements, it has long been known that some of these measurements may or may not be distributed normally. However, there has been no general agreement about the exact nature of these distributions, or the extent that these distributions do or do not differ significantly from that to be expected. It would seem, therefore, important to test the normalcy of commonly employed measures, since many of the distributions of scores in physical education activities are not known.

This study was designed primarily to compare the observed with the theoretical (normal) distributions of anthropometric and physical performance measurements commonly used in physical education with college women. A subproblem was to present percentile scores on selected anthropometric and physical performance measurements.

Method

A random selection of 200 college women from the nonmajor required program at Michigan State University was secured by using a table of random numbers.[1] Each student was contacted by a letter and by her individual in-

[1] For their cooperation in facilitating the collection of data, gratitude is extended to Dorothy Kerth and the other members of the faculty in the Department of Health, Physical Education, and Recreation, Michigan State University.

structor. All subjects expressed willingness to participate in the study. The subjects were divided into two groups. Each group consisted of 100 subjects. Each group completed all measurements in one week. Data on the first group were collected on successive Tuesday nights; data on the second group on successive Thursday nights. All measurements were taken from 6:30 to 8:30 p.m.

The source references for all measurements used in this study are indicated on Table 1. The sources listed describe in detail the individual test item and procedure for administration. The physical performance measurements were divided into two batteries for administration: Battery A—grip, pull, push, back lift, obstacle race, standing broad jump, standing flexion, spinal extension, sit-ups, deep knee bends; Battery B—basketball throw, wall passes, 20-yard dash, chair stepping.

The first group of subjects took the physical performance items in Battery A the first Tuesday and Battery B the second Tuesday. This procedure was reversed for the second group of subjects. The anthropometric measurements

TABLE 1.—MEANS, STANDARD DEVIATIONS, AND SOURCES FOR DESCRIPTION AND ADMINISTRATION OF ANTHROPOMETRIC AND PHYSICAL PERFORMANCE MEASUREMENTS USED IN STUDY

Measures	Mean	Standard deviation	Reference (numbers refer to bibliography)
Age (yrs.)	19.30	.84	(10) Pryor
Height (in.)	64.14	2.48	(10) Pryor
Weight (lbs.)	126.56	16.23	(10) Pryor
Chest Width (in.)	9.64	0.57	(10) Pryor
Bi-iliac width (in.)	10.97	0.59	(10) Pryor
Hip width (in.)	12.63	0.64	(16) Turner
Ankle girth (in.)	8.07	0.51	(16) Turner
Wrist girth (in.)	5.72	0.32	(16) Turner
Pondral index (Hgt./ $\sqrt[3]{\text{Wgt.}}$)	12.79	0.58	(9) Powell
Back lift (dynamometer)	195.23	37.10	(2) McCloy
Push (dynamometer)	40.47	10.35	(2-19) McCloy; Wilson
Pull (dynamometer)	50.45	10.22	(2-19) McCloy; Wilson
Left grip (dynamometer)	68.85	11.72	(2-19) McCloy; Wilson
Right grip (dynamometer)	75.32	12.63	(2-19) McCloy; Wilson
Sit-ups (no. in 30 secs.)[a]	17.12	4.32	(15) Scott
Deep knee bends (no. in 30 secs.)	22.39	3.77	(3) McCloy
Standing flexion (in.)	1.24	2.48	(15) Scott
Spinal extension (in.)	13.05	2.52	(15) Scott
Chair stepping (no. in 1 min.)	45.53	10.10	(14-15) Scott
Basketball throw (dist.—ft.)	39.84	9.71	(11-12) Scott
Wall passes (no. in 15 sec.)	10.35	1.36	(11-12) Scott
20-yard dash (secs.)	3.05	0.28	(17) U. S. Office Ed. Bull.
Obstacle race (secs.)	23.21	2.30	(11-12) Scott
Standing broad jump (ft.)	63.52	9.07	(11-12) Scott

[a] The administration of this test differed from the procedure described in the reference with respect to time.

TABLE 2.—COMPARISON OF RELIABILITIES IN SELECTED PAST STUDIES AND OBJECTIVITIES FOUND IN THIS INVESTIGATION

Measures	Range of reliabilities as reported in selected past studies			Objectivities as found in this investigation
	Low		High	
Height (in.)	.91		.99	.94
Weight (lbs.)	.91		.99	.95
Chest width	.91		.99	.90
Bi-iliac width (in.)	.91		.99	.80
Hip width (in.)	.91		.99	.90
Ankle girth (in.)	.91		.99	.92
Wrist girth (in.)	.91		.99	.93
Back lift (dynamometer)	.62		.97	.57
Push (dynamometer)		.76		.71
Pull (dynamometer)		.89		.74
Left grip (dynamometer)	.46		.95	.83
Right grip (dynamometer)	.54		.95	.81
Sit-ups (30 sec.)[a]		.94		.80
Deep knee bends (no. in 30 sec.)				.56
Standing flexion (in.)		.93		.80
Spinal extension (in.)	.87		.95	.95
Chair stepping (no. in 1 min.)		.95		.41
Basketball throw (ft.)	.89		.91	.80
Wall passes (no. in 15 secs.)		.62		.76
20-yard dash (sec.)				.81
Obstacle race (sec.)		.91		.77
Standing broad jump (ft.)	.79		.88	.90

[a] The administration of this test differed from the procedure described in the reference with respect to time.

were taken on half of the subjects in the first group the first test night, and the rest of the subjects the second test night. This same procedure was followed for the second group of subjects measured on successive Thursday nights. There was no established order for subjects to take the tests in Battery A. All subjects took the chair stepping measure last in Battery B. During the week following the last test period all test items were readministered to a group of 60 subjects.

Instructors in the Department of Health, Physical Education, and Recreation at Michigan State University took all measurements. Whenever possible, the instructor assigned to a particular station worked at that station throughout the study. However, this was not always possible.

The means, standard deviations, and coefficients of objectivity were computed for each measurement.[2] The coefficients of objectivity were determined on two scores for each of 60 subjects on all test items secured from two tests administered. The x^2 (chi-square) was calculated for testing goodness of fit

[2] The high speed electronic computer at Michigan State University was employed to calculate the means, standard deviations, and coefficients of objectivity.

between observed and theoretical (normal) distributions of the 200 records in the physical performance and anthropometric measurements used in the study. Percentile scores were established for college women on measurements used in this study.

Results and Discussion

The means and standard deviations for each measurement are presented in Table 1. A comparison of the reliabilities for each measurement reported in other studies and the objectivities found in this study indicates some marked differences (see Table 2). The greatest discrepancies were found in the back lift and chair stepping measures. The primary problem in the administration of the back lift was the difficulty in selecting the proper link for the chain. The low objectivity found in this study for chair stepping may be one of motivation. The problem was to get the subjects to go all out a second time. Much comment was noted while retaking the chair stepping test. All subjects seemed quite aware that this test brought about extreme muscle soreness and stiffness in the thigh muscles. Also, this concern of the subjects to avoid muscle soreness and stiffness may help to explain the low objectivity as found in the deep knee bends. Both of these measures—chair stepping and deep knee bends—were extremely disliked by the subjects retaking the tests.

During the first administration, most subjects seemed to think it was great fun and tried to give their best. However, most of the subjects became quite aware of how to avoid the exercise stress in the specific measurements which demanded all-out performance. This may account for some of the low objectivities as reported in this study. Also, this was mass testing with different instructors administering and readministering tests, and the coefficients of objectivity in this study were expected to be lower when compared to coefficients of reliability. The low objectivities for pull, push, and back lift seem to be the result of the equipment, e.g., the proper link in the chain for the back lift and the steadiness of the attachment for the pull and the push.

The results of the x^2 (chi-square) test for goodness of fit are presented in Figures 1, 2, 3, 4. In interpreting the x^2 (chi-square) value, a P less than .20 constituted grounds for rejection of the hypothesis that the data were normally distributed (7). The frequency distributions found to compare favorably with the theoretical frequencies were height, weight, chest width, bi-ilac width, hip width, obstacle race, standing broad jump, deep knee bends, standing flexion, wall pass, chair stepping, and the back lift. Therefore, there was no evidence that the total population from which these data are a sample is not a normal distribution. The frequency distributions found to compare unfavorably with the theoretical frequencies were ankle girth, wrist girth, sit-ups, spinal extension, basketball throw, 20-yard dash, pull, push, and grip. Therefore, there was evidence that the total population from which these data are a sample is not a normal distribution.

There was no reason why all distributions should approach the normal form. The true shape of the curve may not resemble the normal. It was not

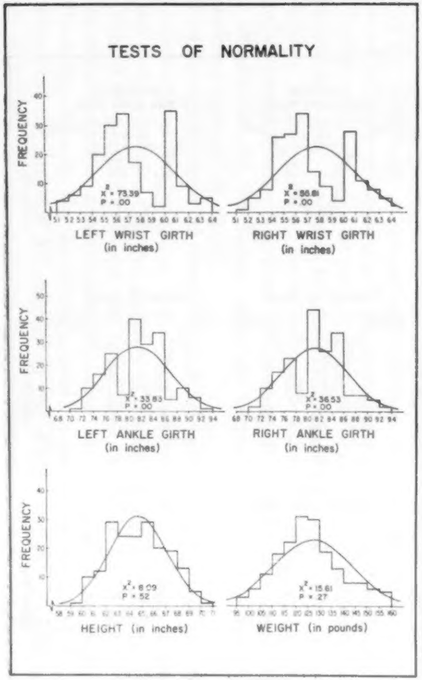

FIGURE I

FIGURE I. Frequency distributions of the records of 200 college women on wrist girth, ankle girth, height, and weight, compared with best-fitting normal curve for same data.

FIGURE II. Frequency distributions of the records of 200 college women on bi-iliac width, hip width, chest width, standing flexion, spinal extension, and 20-yard dash, compared with best-fitting normal curve for same data.

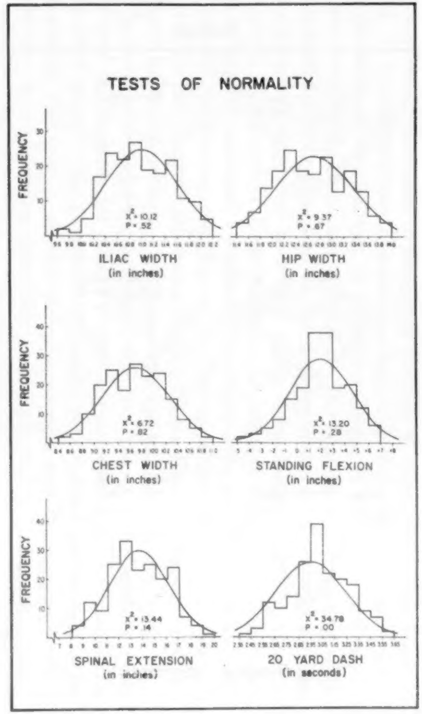

FIGURE II

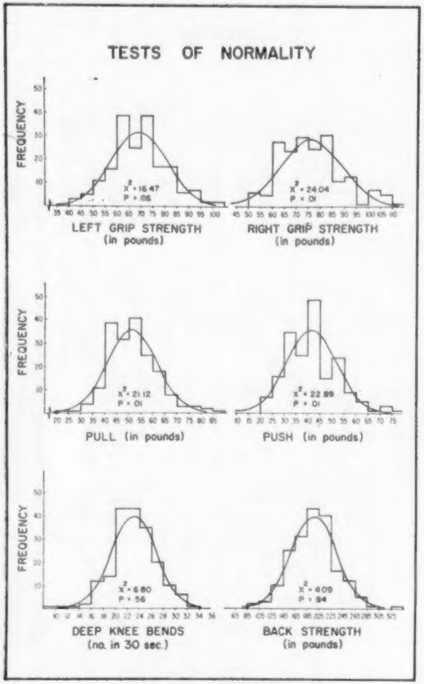

FIGURE III

FIGURE III. Frequency distributions of the records of 200 college women on grip strength, pull, push, deep knee bends, and back strength, compared with best-fitting normal curve for same data.

FIGURE IV. Frequency distributions of the records of 200 college women on wall pass, basketball throw, chair stepping, broad jump, sit-ups and obstacle race, compared with best-fitting normal curve for same data.

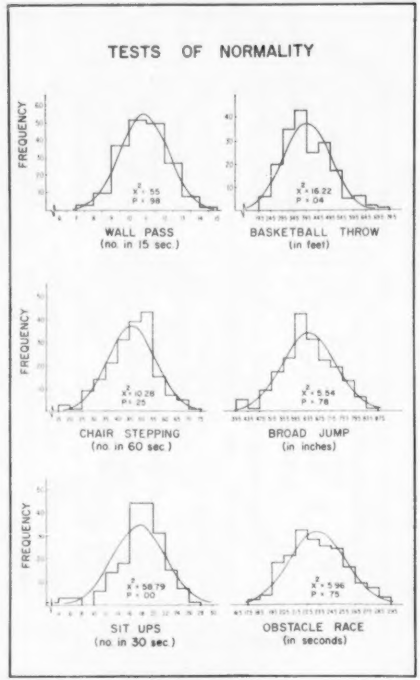

FIGURE IV

the purpose of this study to determine the type of curve which best fitted the data. It was the purpose, however, to determine if the normal curve plotted fits the obtained distributions of the data collected in this study well enough to warrant treating these data as normal. The frequency distributions of the records of 200 college women on the anthropometric and physical performance measures compared with best fitting normal curve are illustrated in Figures I, II, III, and IV. Examination of the frequency distributions for ankle and wrist girth indicated a similarity in shape of the curves—a tendency for a bi-modal distribution (see Figure I). This same observation was found to be true for the grip strength measures (see Figure III). Dominance may play a factor in these measures. Dominance was not indicated in this study.

The percentile tables of anthropometric and physical performance measures used in this study for college women are presented here for possible use with other groups. The percentile standards were constructed because of the non-normal distribution of various measurements and the ease with which ranks may be explained to the students. The physical performance measurements are presented in Table 3. The anthropometric measurements in Table 4. In Table 4, the results of two different techniques for predicting weight in college women are depicted, i.e., Pryor (10) and Turner (16). Some observations in the use of these two techniques for predicting weight of college women in this sample are as follows:

Pryor		*Turner*
3%	Percent with less than one pound deviation from predicted weight.	10%
1-72 pounds	Range in number of pounds overweight.	1-54 pounds
1-27 pounds	Range in number of pounds underweight.	1-27 pounds

There seemed to be a difference of no more than 1 percent between the comparative decile rankings until the extreme limits of underweight or overweight are considered. A subject had a greater chance of falling within one pound of her appropriate weight if the appropriate weight was determined by the Turner technique, e.g., 18 percent fall within this category by the Turner technique and only 3 percent by the Pryor technique. According to both techniques, 70 percent of all the subjects were within 10 percent of their appropriate weight. From the authors' observation, if a subject was excessively over or underweight, the Turner technique seemed to be more accurate in determining appropriate weight.

Since the development of these standards of anthropometric and physical performance measures for college women, certain measures have been selected for use in the nonmajor required program at Michigan State University. The selection of the specific measures was based upon the reliability of the measure as administered in a mass testing situation, the meaning of the measure for the college woman, the use of the measure in the interpretation of different aspects of the program for influencing the college woman's present and future activities. Certain measures were eliminated and replaced by more

TABLE 3.—PERCENTILE SCORES ON SELECTED TESTS AND MEASURES OF PHYSICAL PERFORMANCE

Percentile	Grip Strength (lbs.)						Back lift (lbs.)	Push (lbs.)	Pull (lbs.)	30″ Sit-ups (no.)	30″ Deep knee bends (no.)	Spinal extension (in.)	Standing flexion (in.)	1′ Chair stepping (no.)	Basketball throw (ft.)	Standing broad jump (ft.-in.)	Obstacle race (sec.)	Wall passes (no. in 15 sec.)	20-yd. dash (sec.)	Percentile
	Right grip	Left grip	Stronger Hand		Weaker Hand															
			(Lbs.)	(Lbs. per lb. of body weight)	(Lbs.)	(Lbs. per lb. of body weight)														
100th[a]	110	103	110	.87	103	.83	320	75	85	26	32	21	11.0	70	73	7-3	18.1	14	2.4	100th
95th	98	89	98	.79	89	.68	258	58	73	23	29	17	6.0	63	59	6-6	20.0	13	2.7	95th
90th	94	83	94	.74	83	.65	242	55	66		27	16	4.0	60	53	6-3	20.6	12	2.8	90th
85th	91	79	91	.71	79	.64	234	51	62	21	26		3.2	57	50	6-1	21.0		2.9	85th
80th	88	77	88	.69	77	.61	225	48	59	20	25	15	2.7	55	47	5-11	21.2			80th
75th	85	75	85	.67	75	.59	220	46	56				2.2	53	46	5.9	21.5			75th
70th	83	74	83	.65	74	.58	214		55	19	24	14	2.0	52	44	5-7	21.8		3.0	70th
65th	81	73	81	.64	73	.57	208	44	54				1.8	50	43	5-6	22.1	11		65th
60th	79	72	79	.63	72	.55	204	43	52	18	23		1.5	49	42	5-5	22.3			60th
55th	77	71	77	.61	71	.54	200	42	51				1.4	47	41	5-4	22.6			55th
50th	75	69	75	.60	69	.54	195	41	50		22	13		46	40	5-3	23.1		3.1	50th
45th	73	68	73	.59	68	.52	190	40	48	17			1.3	45	39	5-1	23.3			45th
40th	71	67	71	.58	67	.51	184	39	47		21	12	1.0	44	38	5-0	23.6	10	3.2	40th
35th	69	66	69	.56	66	.50	180	37	46				0.5	42	37	4-11	24.0			35th
30th	68	64	68	.55	64	.49	174	36	45	16	20		0.2	41	36	4-10	24.3			30th
25th	66	62	66	.54	62	.47	170	35	44	15		11	0.0	39	34	4-9	24.8			25th
20th	64	60	64	.52	60	.46	162	33	43	14	19		—.5	37	32	4-8	25.2	9	3.4	20th
15th	62	58	62	.50	58	.44	156	31	41	13	18	10	—1.7	34	30	4-7	25.8			15th
10th	60	55	60	.49	55	.42	148	28	39	12	17	9	—2.2	31	28	4-5	26.5	8	3.6	10th
5th	58	51	58	.46	51	.40	134	25	36	9	15	8	—3.5	27	25	4-2	27.3	7	3.7	5th
0th	49	39	49	.37	39	.34	80	20	21	0	6	6	—10.0	14	21	3-4	29.5	6	4.4	0th

[a] 100 is really the 99th percentile. 0 is the 1st percentile.

TABLE 4.—PERCENTILE SCORES ON ANTHROPOMETRIC MEASURES

Percentile	Age (Yrs.-Mos.)	Weight (Lbs.)	Height (In.)	Pondral index	Chest width (In.)	Bi-iliac width (In.)	Hip width (In.)	Ankle girth (In.)	Wrist girth (In.)	Pryor: Overweight (Lbs.)	Pryor: Percent (OW)	Pryor: Underweight (Lbs.)	Pryor: Percent (UW)	Turner: Overweight (Lbs.)	Turner: Percent (OW)[b]	Turner: Underweight (Lbs.)	Turner: Percent (UW)[c]	Percentile
100th[a]	23-11	197	71.8	11.0	11.8	13.3	14.8	9.7	6.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100th
95th	20-7	158	68.0	11.8	10.5	12.0	13.6	8.8	6.2									95th
90th	20-2	150	67.5	12.1	10.3	11.8	13.4	8.6	6.1	2-3	2%	1-2	1%	2-3	2%	1-2	1%	90th
85th	20-0	144	67.0	12.3	10.2	11.6	13.2	8.5										85th
80th	19-11	138	66.3	12.4	10.1	11.5	13.1	8.4	6.0	3-5	3%	2-3	2%	3-5	3%	3	2%	80th
75th	19-9	135	65.6	12.5	10.0	11.3	13.0	8.3	5.9									75th
70th	19-8	132	65.6	12.6	9.9			8.2		4-6	4%	3-4	3%	5-6	4%	4-5	3%	70th
65th	19-7	130	65.0	12.6		11.2	12.9											65th
60th	19-6	128	64.8	12.7	9.8		12.7		5.8	6-9	6%	4-5	4%	5-7	5%	4-6	4%	60th
55th	19-4	127	64.5	12.8	9.7	11.0		8.1										55th
50th	19-2	125	64.2	12.8	9.6	10.9	12.6	8.0	5.7	8-11	7%	5-7	5%	6-9	6%	6-7	5%	50th
45th	19-1	123	63.8	12.9			12.5	8.0										45th
40th	19-0	121	63.4	12.9	9.5	10.8	12.4	7.9		9-12	8%	8-9	7%	9-11	8%	6-9	6%	40th
35th	18-11	120	63.2	13.0	9.4	10.7	12.3		5.6									35th
30th	18-10	118	62.5	13.0	9.3	10.6	12.2	7.8	5.5	12-14	10%	10-13	8%	12-15	10%	8-10	7%	30th
25th	18-9	115	62.2	13.1	9.2		12.1	7.7	5.5									25th
20th	18-8	114	61.9	13.2	9.1	10.5	12.0	7.6		19-20	14%	13-14	11%	13-16	12%	12-13	10%	20th
15th	18-7	112	61.6	13.3	9.0	10.3	11.9	7.5	5.4									15th
10th	18-5	108	60.8	13.5	8.7	10.2	11.7	7.4		22-26	20%	19-23	16%	28	16%	19-23	14%	10th
5th	18-0	104	60.3	13.7	8.6	10.0	11.5	7.2	5.3									5th
0th	17-3	92	55.5	14.0	7.7	8.9	10.7	5.6	4.9	72	60%	27	22%	54	54%	21-27	18%	0th

[a] 100 is really the 99th percentile. 0 is the 1st percentile.
[b] (OW) = Overweight.
[c] (UW) = Underweight.

useful measures with respect to the above reasons, e.g., chair stepping was replaced with a modified step test with 30-sec. pulse count; obstacle race was replaced with a shuttle race. Each measurement used in the required program today had to have a direct application to the concepts developed in the two-year nonmajor required program, namely, a way to evaluate physical self and present level of condition with respect to physical activities, and a way to evaluate present physical skill and its relationship to future courses in physical education and past movement experiences.

Conclusions

From the statistical analysis of the data, the following conclusions were drawn:

1. A comparison of the coefficients of objectivity of certain measurements taken in a mass testing situation as employed in this study with coefficients of reliability found in other studies indicate some marked differences, e.g., the back lift, chair stepping, obstacle race, deep knee bends, sit-ups, pull, push, and grip.

2. Measurements commonly employed by physical educators that gave a non-normal distribution included ankle girth, wrist girth, sit-ups, spinal extension, basketball throw, 20-yard dash, pull, push, and grip.

3. Measurements commonly employed by physical educators that resembled a normal distribution included height, weight, chest width, bi-iliac width, hip width, obstacle race, wall pass, standing broad jump, deep knee bends, standing flexion, chair stepping, and back lift.

There is no reason why all distributions should approach the normal form. The true shape of curve may not resemble the normal. The normal curve did not fit the obtained distribution for some measurements commonly employed in physical education as used and employed in this study.

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Notes & Comments

NOTES

Relationship between Maximum Isometric Tension and Breaking Strength of Forearm Flexors

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IN A PREVIOUS communication (7), it was shown that measurements of maximum strength made by the use of isometric techniques are valid in expressing isotonic strength of trained subjects. This finding has since received support from Scherrer and Bourgurgnon's (9) discovery that electromyographic observations made during dynamic work are equally valid for static work. The purpose of the present study was to determine the relationship between the maximum amount of isometric tension which the forearm flexors of untrained individuals could exert and their ability to resist forcible extension (breaking strength). Breaking strength measures the force required to overcome maximal resistance (4). The subject is placed in a standard position, with the limb connected to a spring scale. Sufficient pull is exerted to cause the limb to move out of the standard position. The amount of pull required for this purpose is read off the scale and is accepted as representing muscular strength.

The breaking strength tests were introduced by Martin and his coworkers to answer some of the objections that had been made to dynamometer testing, but apparently they made no objective comparison of the relative scores of the two techniques. McCloy and Young cite a German paper to the effect that "the breaking strength of a group of muscles that function together is usually 25 percent greater than the pulling strength of the same group of muscles," (1) and Hill and Howarth report, "Contracting muscles resist an applied stretch very strongly, with a force which may be twice that of a maximal isometric tetanus (2)." Otherwise there appears to be a dearth of material on this subject in the literature.

Eighteen male students at the College of Osteopathic Physicians and Surgeons served as subjects. The technique for the breaking point test differed only slightly from that described by Martin and Rich for the testing of the strength of elbow flexion and has been described in detail elsewhere (8). Briefly, measurements were taken with the subject supine on a plinth with both feet firmly braced against a footboard, with the forearm of the preferred side at an angle of 80 degrees to the humerus, and the hand in line with the forearm. The subject gripped a Y handle, to which was attached a spring balance. At the order, "hold back," the subject did his utmost to resist extension of the joint, while the tester pulled on a handle attached to the spring balance until the subject's forearm reached the vertical. The pounds of pull required to accomplish this movement were recorded. Isometric strength tests were conducted with the subject supine on the plinth, the forearm at an angle of 90 degrees to the humerus, and maximum contraction applied against the Y handle with the latter attached by a flexible wire cable to a Baldwin SR-4 load cell. The load cell, in turn, was connected with an Offner Electronic Dynograph Amplifier and ink writer, by which the amount of tension exerted against the load cell was recorded. Prior to the actual testing, the subjects visited the laboratory, familiarized themselves with the apparatus, and practiced both tests. Later in the week each subject was tested on two different days, once with the breaking point

test given first and once with the isometric first. Comparison of test-retest scores gave r = .93 for the isometric contraction and r = .91 for the breaking point test.

The mean score for the isometric contraction was 49.5 lbs.; that for the breaking point test was 50.9 lbs. When these were compared by use of Student's t, the results were not significant at the .05 level ($t = 0.096$ with 35 degrees of freedom).

On the basis of this and the previous study, it would appear that isotonic, isometric, and breaking point strength tests give similar results. It is now rather generally agreed that the training stimulus to increased muscular strength and hypertrophy is the development of tension(6). The fact that a muscle develops the same tension during breaking point strength tests that it does during isotonic tests would appear to offer an explanation for Logan's finding that gains in strength resulting from eccentric exercises are practically identical with those resulting from concentric exercises(3).

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(Submitted 2/24/60)

Research Abstracts

Prepared by the Research Abstracts Committee of the Research Council, D. B. VAN DALEN, Chairman

103. ALTSCHUL, RUDOLF, and SMART, TERRY A. "Influence of Water Deprivation on Serum Cholesterol in Rabbits." *Geriatrics* 14: 461-64; July 1959.

Rabbits were deprived of water for 48 hours. This resulted in a significant rise in serum cholesterol. The increase of this level is greater than increases in red blood cells or hematocrit. Apparently a factor other than simple hemoconcentration is involved. Stress, decreased cholesterol degredation, and/or decreased excretion may have influenced this level.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

104. BAGCHI, B. K., and WENGER, M. A. "Electro-Physiological Correlates of Some Yogi Exercises." *The First International Congress of Neurological Sciences* 3: 132-49; 1959.

EEG records were obtained of 14 yogis during meditation. Meditation did not show the electrical rhythm of the brain characteristic of sleep. The rise in electrical resistance of the skin found during meditation is known to be a sign of relaxation. The evidence suggests yogi meditation is a deep relaxation of a certain aspect of the autonomic nervous system without drowsiness or sleep and at the same time a type of cerebral activity without highly accelerated electrophysiological manifestations. In spite of the spiritual halo which surrounds the so-called heart-stopping experiments, these are simply the well-known Valsalva maneuver. This research needs to be continued, as it may throw light on little-known physiological or psychological mechanisms.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

105. BISHOP, P. M. F. "Male Sex Hormones." *British Medical Journal* 5167: 184-86; January 16, 1960.

The true male hormone is testosterone. It is inactive when given by mouth, its effect is transient if given by injection, and it is usefully therapeutically only when implanted. Methyltestosterone, however, is an efficient oral androgen. Androgens are administered to provide replacement therapy, to counteract the effect of prolonged or excessive oestrogen influence in certain functional menstrual disorders, and to encourage protein anabolism. At present the search is for substances with powerful anti-oestrogenic or anabolic action which are weak androgens so that they may be administered to women without fear of masculinizing side effects. Methyltestosterone appears likely to be replaced by the new 19-nortestosterone compounds.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

106. BUHLER, CHARLOTTE. "Theoretical Observations About Life's Tendencies." *American Journal of Psychotherapy*, 13: 561-81; July 1959.

Present-day thinking about life's basic tendencies moves between an extreme which conceives of man as a whole and one which considers that biological factors in no way determine an individual's values and goals. The author believes that physical factors codetermine motivation and behavior in that they delimit the conditions under which an individual must function and the equipment with which he must work. Her theory of basic tendencies was developed from the following data:

1. Activity originating within the organism establishes built-in tensions that activate the organism. This may be accompanied by a decrease of entropy and a spontaneous transition to states of higher heterogeneity and complexity.

2. A tendency to maintain homeostasis and one to change are equally basic.

3. There are four basic tendencies of life: need satisfaction, self-preservation, adaptation, and productivity. Under unfavorable conditions any of these may turn into its opposite.

4. Fundamental psychoanalytical thinking holds there is only one basic tendency: need gratification or tension reduction. This does not do justice to the interplay of the primary adaptive tendencies.

5. Alexander considers the principle of surplus energy necessary to understand play and creative action. It may be simply discharged or transformed into a product which amplifies the individual.

6. K. Buhler identifies three types of pleasure: satiation pleasure, function pleasure, and pleasure of creating. Probably each must embody some form of self-expression.

7. C. Buhler has demonstrated a primary positive striving which leads from manipulation to mastery.

8. Maslow describes a strength which leads healthy personalities to enjoy challenges rather than avoid them.

9. French conceives of a motivating pressure which drives people toward goals. The integrative mechanism musters and disposes energies to obtain future ends.

10. Integrated action must be preceded by an appraisal of the situation and of one's own potential.

11. Goldstone thinks of self-realization as the goal of life. Fulfillment implies creative accomplishments, assistance to the welfare of others, and "peace of mind." This may be defined in terms of the four basic tendencies being in good balance, integrated, and having reached their goals.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

107. Coppen, A. J. "Body-Build of Male Homosexuals." *British Medical Journal* 5164: 1443-45; December 26, 1959.

Sheldon found there were no distinctive features of homosexual physique recognizable from a somatotyping photograph, but stated the majority of homosexuals are recognizable by secondary gynandromorphy. The present investigation was to determine whether homosexuals have an abnormal discriminant androgyny score when judged by the formula 3 x biacromial—1 x bi-iliac diameters (in cm.). There is evidence that this score is correlated with sexual characteristics and abnormalities. A second score was obtained by applying the fat-bone formula to x-ray pictures of the calf: 1 x bone diameter (mm)—0.4 x fat diameter (mm). This has been shown to differentiate the sexes well. A group of 31 male homosexuals was measured and compared with controls. They had a lesser biacromial diameter than the controls. The androgyny score did not differentiate them better than did the biacromial diameters. The fat-bone indices showed no differences in the two groups. It was concluded the homosexuals have a body-build similar to that of of other psychiatric patients and that it could not be related specifically to their sexual abnormality.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

108. Davis, Peter R. "The Causation of Herniae by Weight-Lifting." *Lancet* 7095: 155-57; August 22, 1959.

Lifting a heavy weight may cause hernia of the anterior abdominal wall. It has been suggested that the stomach might be forced into the chest by pressure differences across the diaphragm. That there is a change in intrathoracic pressure during weight lifting is suggested by the gasp which accompanies it. Pressures were measured in five subjects by placing rubber balloons in the oesophagus, stomach, and/or rectum. The subjects then lifted increasingly heavy weights in the erect position, while stooping, and in the prone position. There was little pressure change when weights were lifted in the erect position. There was considerable increase in pressure when stooping, and there was a direct relationship between the magnitude of the weight and the height of the pressure.

To maintain a rise in intrathoracic pressure of the magnitudes encountered, the glottis must be closed, and its sudden opening when a breath has to be taken may cause the explosive decompression of both cavities and account for the gasp. During the subsequent inspiration the descending diaphragm builds up the intra-abdominal pressure while lowering that in the thorax, and again creates a large pressure difference in the two cavities. The high thoracic pressure is reestablished by closing the glottis and relaxing the diaphragm. This suggests that weight lifting should be avoided in the postoperative period following repair of the diaphragmatic lesion.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

109. Del Polo, Joseph A. "Authoritarian Trends in Personality as Related to Attitudinal and Behavioral Traits of Student Teachers." *Journal of Educational Research* 53: 252-57; March 1960.

This study investigated the relationship between an individual's personality structure and his opinions and attitudes toward pupil-teacher relationships and his observable behavioral traits in a classroom setting. The aspect of personality studied was that of the authoritarian personality struction and the test used was that of Webster, Sanford, and Freedman. The measure of attitudes toward pupil-teacher relationships was the Minnesota Teacher Attitude Inventory. In all 366 sophomore and junior college students participated in the study. The study concluded that (1) a significant relationship exists between an individual's personality structure and his opinions and attitudes toward pupil-teacher relationships and his observable behavioral traits in a teaching situation and (2) authoritarian students tend to display behavioral traits during student teaching which imply an inability to establish harmonious pupil-teacher relationships. Equalitarian students tend to establish harmonious pupil-teacher relationships.

110. Donnan, F. de S. "Physique and Hazardous Occupations." *British Medical Journal* 5154: 728-31; October 17, 1959.

The physique and choice of occupation of three groups of men serving in the Royal Marines—swimmer-canoeists, a highly arduous branch; general duty, the normal training branch; men belonging to miscellaneous trades not involving major hazards—were studied by Parnell's methods of measurement. Swimmer-canoeists were significantly taller and heavier, with mesomorphy dominant or strongly represented. General duty marines and men engaged in less hazardous trades showed a more scattered distribution. Endomorphs and ectomorphs were absent in the first group, but appeared in the latter two. Physique estimation appears to be useful in drawing negative conclusions regarding suitability for arduous training.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

111. DuVries, Henri L. "The Orphan of Medicine." *The Illinois Medical Journal* 116: 279-81; November 1959.

The anatomist F. W. Jones observed that the foot was the most distinctly human part of man's anatomical make-up. Nevertheless, this part of our skeleton has been given only meager study by the medical profession. The first metatarsophalangeal articulation is one of the most complex joints in the body, but is usually treated on an arbitrary basis. Five times as many scientific articles have been published on the hand as on the foot, notwithstanding the greater difficulties to which the foot is subjected. More than 60 percent of our population suffers from painful feet, induced mainly by poorly designed shoes; 80 percent of the shoes worn are of the wrong size. Once the condition becomes chronic, removal of the cause—the ill-fitting shoe—may be insufficient to alleviate symptoms.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

112. Efron, Herman Y.; Mark:, Harry K.; and Hall, Richard. "A Comparison of Group-Centered and Individual-Centered Activity Programs." *AMA Archives of General Psychiatry* 1: 120-23; November 1959.

Levine, Marks, and Hall found psychiatric patients working with a lawn-mowing detail made better progress than did those assigned to O.T. Three possible explanations were

offered: (1) more group feeling and patient interaction existed in the lawn-mowing detail; (2) greater ego satisfaction resulted from a real job than from busy work; and (3) O.T. was more complex and created greater stresses. The present study set up an experimental situation to evaluate the first two hypotheses. It was concluded that neither group activity nor ego gratification per se explained the results. The therapeutic effect of lawn-mowing may result from its freedom from stress and decisions. Many patients resented having to do this work; removing some of the secondary gains from illness may allow for healthier motivation to manifest itself. Some support is added to the hypothesis that the personality of the therapist is more important than the work itself.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

113. Ellis, Norman R., and others. "Motor Learning and Retention in Normals and Defectives." *Perceptual and Motor Skills* 10: 83-91; April 1960.

Retention and related phenomena were tested in 80 normal and 80 defectives after short and long rest intervals. Ss, assigned to four subgroups, practiced on the standard pursuit rotor for two blocks of twenty 20-sec. trials, with 20-sec. intertrial intervals and a 5-min. interblock interval. One or 28 days after training, subgroups received 10 retention trials. The results showed that, over-all, performance after the 5-min. rest and after the retention intervals was significantly better in the normals. Also, the normals showed larger warmup effects. Little forgetting occurred over the intervals used and comparisons between the groups did not uncover clear-cut differences. The results suggest a differential buildup of inhibitory potential in normals and defectives.—*D. B. Van Dalen.*

114. Engel, R. W. "Food Faddism." *Nutrition Reviews* 17: 353-55; December 1959.

The average consumer, particularly the older segment, has difficulty in distinguishing between the sensible approach to good nutrition and the faddist approach. Some glaring mistruths about nutrition have been presented under the guise of scientific literature. Faddists often claim that modern farming depletes the soil of amino acids and that chemical farming and food enrichment lead to disease. No documentation is offered in support of such claims. Actually the conditions in most cultivated soils favor the rapid formation of nitrates from organic nitrogen compounds. The statement that soil depletion causes malnutrition appears without foundation. A very comprehensive study at Michigan State University failed to disclose any differences in the health and milk production of cattle fed on fodder from soils of low fertility. There is no evidence that deficiency of amino acids can be demonstrated in ruminant species. Protection of the public against food faddists may be obtained by governmental action, better education, improvement in nutritional knowledge of physicians, and presentation of facts by professional organizations.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

115. Erskine, L. Allen. "The Mechanisms Involved in Skiing Injuries." *American Journal of Surgery*, Part II. 97: 667-71; May 1959.

Two basic types of mechanisms are involved in all downhill skiing accidents, except for direct collision. In the first the forward motion is abruptly stopped. The skier lunges forward, propelled by his own momentum, and the tendoachillis or the peroneal groove, or the skiis must give. The second type of accident occurs while the skier is turning and torque is added to the forces present. The momentum carries the skier around, but if the ski tip cannot move fracture occurs somewhere between the ankle and the knee. The slower the person is going, the lower on the leg is the break.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

116. Faust, Margaret S. "Developmental Maturity as a Determinant in Prestige of Adolescent Girls." *Child Development* 31: 173-84; March 1960.

Tyron's Guess Who Test, including an additional pair of items designed to measure prestige, was administered to 731 girls in the sixth through the ninth grades. Level of physical maturity was assessed by means of menarcheal age and it served as the basis of classifying the girls into four developmental groups on each grade level. It was found

that the level of development is not a single factor in determining a girl's status in a group, but it is an important part of a composite of factors in creating a girl's reputation during adolescence. A discrepancy between rate of developmental change and rate of change in prestige-lending evaluations during adolescence was noted and was interpreted in terms of the different meaning which early and late development have for girls at different times during adolescence. After the transition to junior high school, the more favorable reputation scores were ascribed to the physically accelerated girls.—*D. B. Van Dalen.*

117. Fearnley, G. R., and others. "Effect of Beer on Blood Fibrinolytic Activity." *Lancet* 7117: 184-86; January 23, 1960.

Various forms of stress increase blood fibrinolytic activity, but until now only alimentary lipaemia and pregnancy have been known to diminish it. An investigation of the effects of alcoholic drinks indicated that beer, cider, and white wine greatly lowered fibrinolytic activity, whereas whisky, gin, and absolute alcohol did not. This suggests some substances produced during fermentation but absent in distilled liquors may reduce blood fibrinolytic activity. Until blood fibrinolytic activity has been proved to be of functional importance, it would be premature to speculate about the significance of these findings, but they do not justify any further restrictions on sufferers from vascular disease.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

118. Felton, Jean Spencer. "The Coffee Break." *Industrial Medicine and Surgery* 28: 433-46; October 1959.

Some time in the early 1940's the concept of regularly scheduled rest periods came upon the war production scene. In 1936 Haggard and Greenburg had noted that there were production falls in the late morning and late afternoon and recommended five meals a day instead of three. Samuelson believes that between-meal feeding can elevate the blood sugar level and possibly reduce the number of accidents. To compensate for the fatigue pattern, employers have granted 5 to 15 minute rest periods, during which food and beverages are made available. Surveys of 1500 companies show that 70 to 90 percent grant some form of coffee break.

This new way of working has effected nearly everyone in industry. Scientists frequently take excessive coffee breaks. In many places rest breaks are provided by law; in other instances specific agencies of the federal government have authorized rest periods. Courts have ruled that such breaks are beneficial to the employer in that they promote more efficiency and result in greater output, as well as constituting an accepted part of employment generally. Accidents occurring during such breaks are compensable.

The coffee companies have skillfully slanted their advertising to present the coffee break as a right, part of American living, and an aid to production. However, the whole subject needs exploration on a scientific basis before claims that coffee breaks produce a rise in production and morale can be accepted.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

119. Franklin, D. L.; Ellis, R. M.; and Rusher, R. F. "Aortic Blood Flow in Dogs During Treadmill Exercise." *Journal of Applied Physiology* 14: 809; September 1959.

Measurements of instantaneous blood flow through the thoracic aorta were obtained on intact dogs while they walked on a treadmill at 3 m.p.h., 5 percent grade. The intriguing features of this work are (1) that a successful continuous *in vivo* method for measuring aortic flow in animals has been worked out and (2) that under certain experimental conditions exercise does not produce an increase in stroke volume, at least not in the dog. The statement by the authors—"increased stroke volume is neither an essential nor a consistent feature of the cardiac response to exercise"—seems overly restrictive in view of many results reported in the literature particularly for severe exercise. Nevertheless, controversy frequently serves to clarify issues and the authors have indeed precipitated controversy.—*E. R. Buskirk.*

120. Heller, Stanley S.; Hicks, William R.; and Root, Walter S. "Lung Volumes of Singers." *Journal of Applied Physiology* 15: 40-42; January 1960.

The tidal volume, inspiratory capacity, inspiratory reserve volume, expiratory reserve volume, and vital capacity were measured on 21 subjects with no professional vocal training and 16 professional singers. No differences were observed which could not be explained on the basis of body surface, age, or doubtful measurements. In males the differences in body surface are by far the most significant.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

121. Jokl, Ernst. "The Future of Physical Education." *American Turner Topics* 19; May-June 1959.

Up to the present physical education has been an empirical subject. Only recently has it been understood that physical education and neurophysiology alone among the sciences are concerned with the mechanisms by which mind materializes mental events through movement. It is only through movements that human minds can communicate with other minds. Tests, measurements, statistics, and other quantitative evidences by themselves mean nothing; it is values alone that determine the status of an event. Kinetic patterns and ethical content are but different manifestations of a single situation. Physical educaors must utilize the tradition of the arts, which have always acknowledged the primacy of content over technique.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

122. McAllister, Ferdinand F., and others. "The Accelerated Effect of Muscular Exercise on Experimental Atherosclerosis." *AMA Archives of Surgery* 8: 54-60; January 1960.

Many articles extolling the virtues of muscular exercise have appeard, and both laboratory and clinical evidence indicate that progressive muscular exercise seems to speed the development of collateral circulation. Ten dogs were placed on a standardized diet. Five ran 5 miles per day, 6 days a week, on a treadmill at a 5 percent incline, at 5 m.p.h. Five received a minimum of exercise. In general the exercised animals developed higher cholesterol levels and showed a higher degree of atherosclerosis. This may be a species difference and not applicable to the human; on the other hand it may indicate persons with known atherosclerosis and abnormally high serum cholesterol should not participate in vigorous or protracted exercise.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

123. Marmor, Leonard. "Medial Epicondylitis." *California Medicine* 91: 23; July 1959.

The great deal written about lateral epicondylitis (tennis elbow) contrasts with the little written about medial epicondylitis. In the latter condition the patient usually complains of pain about the elbow, decided local tenderness over the medial epicondyle, with swelling or erythemia, pain evoked by resisted flexion of the wrist and by pronation, and weakness of grip. It is caused by constant minor trauma and tension of the tendon attachment to the medial epicondyle. Pain and symptoms are relieved following local injection of the epicondyle and conjoined tendon with 2 cc. of one percent lidocaine hydrochloride (Xylocaine (R)) and 25 mg. of hydrocortisone in the same syringe. In a few cases it was necessary to apply a volar mold for several weeks. In more severe cases stripping the tendon from the epicondyle may be indicated.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

124. Orloff, Marshall J. "Species Differences." *Surgery* 46: 819-20; October 1959.

Much of the progress in medicine has resulted from animal experimentation. Nevertheless, differences exist between man and laboratory animals. These include differences in susceptibility to drugs, cardiorespiratory system, nutrition, and physiology. Investigators usually report that findings in animals may have significance for humans, but all too often this note of caution is overlooked. The phenomena of species difference and its implications regarding the application of observations on animals to man must be kept in mind.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

125. MEDLEY, DONALD M., and MITZEL, HAROLD E. "Some Behavioral Correlates of Teacher Effectiveness." *Journal of Educational Psychology* 50: 239-46; December 1959.

Five measures of effectiveness and three measures of classroom behavior were obtained on 49 beginning teachers in New York City public elementary scrools, and analyzed with statistical controls on differences between schools and differences between classes within schools. The five measures of effectiveness were found to center around two distinct aspects of effectiveness. Supervisory ratings and pupil's reactions to their teachers ability to get along with children; teachers self-ratings and measures of pupil gains appeared to reflect effectiveness in stimulating pupils to learn to read. Pupil-teacher rapport was found to be related to emotional climate and, probably, to verbal emphasis in classroom behavior. Supervisors rated those teachers who had the friendliest classrooms as most effective. Teachers who rated themselves most effective in teaching fundamental skills tended to allow their pupils less opportunity to work in small, autonomous social groups. —*D. B. Van Dalen.*

126. PITMAN, JOE. *A Comparative Study of the Effects of a Weight Training Program on Junior High School Boys."* Master's thesis. DeLand, Florida: Stetson University, 1959.

Forty junior high school boys participated in a weight training program two days a week for a period of six months. Thirty seven boys served as controls. Test items consisted of the Junior A.A.U. Physical Fitness Tests, anthropometric measurements, and the California Test of Personality, Intermediate Form AA. The experimental group registered a significant difference at the 5 percent level over the control group in anthropometric measurements and in five of the six physical fitness tests. No significant improvement was found in the personality test. Only one injury occurred during 1,824 exposures to weight training.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

127. POWELL, MARVIN, and FERRARO, D. D. "Sources of Tension in Married and Single Women Teachers of Different Ages." *Journal of Educational Psychology* 51: 92-101; April 1960.

Reaction times on 25 single and 25 married elementary school teachers in four age groups (20-60) were obtained to stimulus words representing seven areas of psychological adjustment. Differences between the married and single were especially large in the areas of emotional tendencies, heterosexual relations, social acceptability, and physical health, with single women's responses reflecting greater tension in each of these areas. In two other areas, marital status differences were reliable for only one or two age groups: religion (30-39 years) and vocational outlook (30-39, 40-49 years). In the remaining area-teacher supervision relationships—no difference appeared at any age level.—*D. B. Van Dalen.*

128. RAFI, AMIN A. "Motor Performance of Certain Categories of Mental Patients." *Perceptual and Motor Skills* 10: 39-42; February 1960.

Five motor tests—dotting, ring, maze, steadiness, and tapping—were given for two minutes each to three groups of 50 patients—mild schizophrenics, chronic schizophrenics, and nonschizophrenics and 50 normal controls. Groups were divided equally as to sex. Normals made significantly fewer errors than the other groups. Chronic schizophrenics performed worse than the two other abnormal groups.—*D. B. Van Dalen.*

129. RARICK, G. LAWRENCE, and LARSEN, GENE L. "The Effects of Variations in the Intensity and Frequency of Isometric Muscular Effort on the Development of Static Muscular Strength in Pre-Pubescent Males." *Internationale Zeitschrift Fur Angewandte Physiologie Einschliesslich Arbeitsphysiologie* 18: 13-21; September 1959.

One daily isometic exercise bout at two-thirds maximum tension is as effective in developing wrist flexion strength in postpubescent males as is more frequently repeated

exercise bouts as higher levels of tension. The effects of such exercise programs on children and preadolescents have not been extensively explored. One experimental group of prepubescents trained with a single 6-sec. bout at two-thirds maximum tension, as proposed by Hettinger and Mueller. A second group trained at 80 percent maximum tension, with the frequency of daily 6-sec. bouts varying progressively from 5 on Monday to 8 on Thursday of each week. Both groups achieved substantial gains, but that of the second group was approximately two and one-half times as great as that of the first group. The loss in strength for both groups four weeks after discontinuing training was significant. Prepubescent males may be sensitive to isometric strength building stimuli at tension levels higher than two-thirds maximum.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

130. Rasch, Philip J. "The Functional Capacities of a Yogi." *Journal of the American Osteopathic Association* 58: 520-23; April 1959.

A study was made of the functional capacities of an experienced yogi. Physical examination revealed a well-nourished body. Dynamometric strength scores were about average for a man of his size, but his performance in the Harvard step test was poor. Scores in both tests may reflect a lack of experience with situations requiring maximal physical exertion. Respiratory and electroencephalographic studies suggested that the effects alleged to result from controlled breathing may be attributed to hyperventilation. Respiratory capacity was less than that predicted by standard formulae for an individual of the size of the subject. Roentgenographic examination revealed no pathological changes resulting from the practice of techniques stressing extreme flexibility.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

131. Ritchey, Sterling J. "Ligamentous Disruption of the Knee." *U. S. Armed Forces Medical Journal* 11: 167-76; February 1960.

Traumatic disruption of knee ligaments is a disability event resulting in an unstable knee that becomes a life-long handicap. A person with an unstable knee can be taught a protective gait and cautioned to avoid unguarded weight-bearing movements, strenuous weight-bearing activity, and uneven surfaces in walking, and the thigh musculature can be strengthened, but a functional knee can be assured only if ligamentous continuity is restored by early reparative surgery.

The cruciate ligaments stabilize the knee primarily in the anteroposterior direction. The collateral ligaments primarily stabilize the knee against angular force. Most ruptures of these ligaments occur from blows rather than from twists. Usually the patient can describe the mechanism and direction of the applied force, and this provides a diagnostic clue.

Surgical repair must be performed promptly. The knee is maintained in a plaster cast with the knee flexed at 135°-150° postoperatively for 21 days. Supervised motion is then started in flexion only. Six weeks after surgery, extension is initiated. Rehabilitation is slow, and about 16 weeks is required for the recovery of quadriceps power.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

132. Seltzer, Carl C. "Masculinity and Smoking." *Science* 130: 1706-07; December 1959.

A study was made of 252 men who had attended Harvard. Each individual was rated with respect to his masculine component, i.e., the element of masculinity in the individual as indicated by his external morphological features. It was found there is a significant correlation between the strength of the masculine component and smoking habits. Weakness of this component is significantly more frequent in smokers than in nonsmokers, and significantly more frequent in heavier smokers than in nonsmokers and moderate smokers combined. Increased frequency of the degree of weakness of the masculine component is consistent and progressive from nonsmokers to the heavier smokers. Smoking may reflect personality and behavioral traits which are characteristic of an individual's biological make-up. Previous studies indicate that individuals with a weakness of the masculine com-

ponent have an aversion for strenuous exercise, are apt to be low in physical fitness, are less well integrated, and are more inhibited.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

133. Semler, Ira J. "Relationships Among Several Measures of Pupil Adjustment." *Journal of Educational Psychology* 51: 60-64; April 1960.

Successive measurements of peer acceptance (Sociometric and Ohio State Acceptance) and pupil responses on a self-report test (California Test of Personality) were made on 483 fifth-grade children. A moderate set of intercorrelations among the several pupil adjustment measures was obtained. Significant sex differences were evident in correlations involving teacher ratings and self-reports. Sex differences in relationship patterns depended upon sex of teacher when teacher ratings and sociometric status correlations were considered. General regression data did not describe individual classroom relationships. —*D. B. Van Dalen.*

134. Shapiro, Arthur K. "The Placebo Effect in the History of Medical Treatment: Implications for Psychiatry." *American Journal of Psychiatry* 116: 298-304; October 1959.

"Placebo" is Latin for "I shall please." It is a medication which operates through a psychological mechanism to produce a therapeutic effect independent of its pharmacological effect. Until the beginning of scientific medicine 70 or 80 years ago, the history of medical treatment was the history of the placebo effect. Despite the uselessness of the drugs and procedures generally employed, the physicians did help their patients. The placebo effect is thus related to the doctor-patient relationship. The physician's most important therapeutic agent is his medical degree. Psychiatry has inherent factors which maximize placebo effect potentialities, as the doctor-patient relationship is the major tool in all psychotherapeutic methods of treatment.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

135. Sherwin, Albert C. "Musical Creativeness and Emotional Disturbance." *Bulletin of the New York Academy of Medicine* 36: 56-68; January 1960.

Since the introduction of dynamic psychiatry, interest has focused on the relationship between creativeness and emotional disturbance. Some believe that creative expression is associated with sublimation of unconscious needs or conflicts, and that successful therapy might hinder the creativity. The creative drive usually appears early in life, and we still await a first-class woman composer. Music is an abstract and highly symbolic medium of expression. It does not communicate until the composer finds a performer. Psychological factors probably determine whether a man is a creator or a performer. Composers as a group do not seem subject to any single kind of illness or to have certain personality traits in general. Kubie said we cannot tell why a man chooses music or some other art form until we have solved the problem of the choice of neurosis. But clinical investigation of the psychodynamics of musical ability and creativeness might reveal how a composer came to choose this medium of expression, even though it did not answer the why.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

136. Weaver, Carl H. "Instructor Rating by College Students." *Journal of Educational Psychology* 51: 21-25; February 1960.

This study found that student ratings of instructors were biased in the direction of the grades which they expected to receive in the course. Most of the student bias in instructor rating was directed toward the teaching skills and abilities of the instructor. In general, this student bias did not affect ratings of instructor personality variables. The evidence suggested that student rating of an instructor's teaching skill was not a product of a popularity halo. Students who expected to receive C's seemed to be generally less discriminating in their appraisal of their instructors than students who expected to receive higher marks. Their relatively narrow dispersion of scores suggested that their rating behavior conformed to a culturally determined norm.—*D. B. Van Dalen.*

Announcement to Members

At its annual convention in April 1960, the American Association for Health, Physical Education, and Recreation took decisive action to assist in raising standards of professional preparation, linking this action with a new AAHPER membership requirement.

• The Association designated the National Council for the Accreditation of Teacher Education as the official accrediting agency for teacher education in health, physical education, and recreation. Appropriate organizations and agencies are being urged to support NCATE accreditation in every possible way.

• The Association also stipulated that after June 1, 1964, *all new* professional, fellow, life, and life fellow members must have at least one graduate or undergraduate degree, with a major or minor in health, physical education, or recreation, from an NCATE-accredited institution. After this date, any person who permits his membership to lapse more than one year must fulfill the requirement made of *new* members. Persons applying for membership after June 1, 1964, who do not meet the above requirement may be designated as associate members. (An article in the October 1960 JOURNAL by Arthur A. Esslinger, past president of AAHPER, explains these actions more fully.)